POWER USER

PRESARIO 7000T-933

$1899‡

As low as $53 per month†

Intel® Pentium® III Processor, 933 MHz
128 MB 133 MHz SyncDRAM expandable to 384 MB
30.0 GB (7200 rpm) UltraDMA Hard Drive[1]
16X DVD-ROM Drive[5]
32 MB nVidia TNT2 M64 Pro Graphics
56K ITU V.90 Modem[3]
SoundBlaster™ Live! Value Audio
JBL Platinum Speakers with Digital Audio Port
Compaq CV735 17" Monitor (16.0" VIA)
Free Y@P™ Internet Phone[8]

Personalize by choosing:

Compaq CV935 19" Monitor (18.0" VIA): Add $180
8X CD-RW Drive[4]: Add $199

MUSICIAN

PRESARIO 7000T-866

$1799‡

As low as $51 per month†

Intel Pentium III Processor, 866 MHz
128 MB 133 MHz SyncDRAM expandable to 384 MB
20.0 GB (7200 rpm) UltraDMA Hard Drive[1]
40X Max CD-ROM Drive[2]
8X CD-RW Drive[4]
32 MB nVidia TNT2 M64 Pro Graphics
56K ITU V.90 Modem[3]
SoundBlaster Live! Value Audio
JBL Platinum Speakers with Digital Audio Port
Compaq CV735 17" Monitor (16.0" VIA)
Free Y@P Internet Phone[8]

Personalize by choosing:

DVD-ROM Drive: Add $50
Klipsch ProMedia V.2 400 Watt Speakers: Add $185
Compaq *iPAQ*™ Personal Audio Player: Add $249.99

PHOTO ENTHUSIAST

PRESARIO 7000T-800

$1399‡

As low as $39 per month†

Intel Pentium III Processor, 800 MHz
128 MB 133 MHz SyncDRAM — up to 11 MB Shared for Video
20.0 GB UltraDMA Hard Drive[1]
16X DVD-ROM Drive[5]
32 MB nVidia TNT2 M64 Pro Graphics
56K ITU V.90 Modem[3]
Creative Labs 1373 Audio with 128 Voices
JBL Platinum Speakers with Digital Audio Port
Compaq CV735 17" Monitor (16.0" VIA)
Free Y@P Internet Phone[8]

Personalize by choosing:

Agfa Snap Scan USB Scanner: Add $99
FujiFilm MX-1200 Digital Camera: Add $289

POWER USER

PRESARIO 1800T-850

$2999‡

As low as $84 per month†

Intel Pentium III Processor, 850 MHz,
featuring Intel SpeedStep™ Technology
15.0" TFT SXGA+ Active Matrix Display
64 MB SyncDRAM
10.0 GB UltraDMA Hard Drive[1]
8X DVD-ROM Drive[7]
ATI Mobility M-128 with 16 MB Video Memory
56K ITU V.90 PCI Modem[3]
Integrated 10/100 BaseT Network Port

Personalize by choosing:

CD-RW Drive[4]: Add $150
128 MB SyncDRAM: Add $200
32.0 GB (5400 rpm) UltraDMA Hard Drive[1]: Add $450

TRAILBLAZER

PRESARIO 1800T-800

$2799‡

As low as $78 per month†

Intel Pentium III Processor, 800 MHz,
featuring Intel SpeedStep Technology
15.0" TFT XGA Active Matrix Display
64 MB SyncDRAM
15.0 GB UltraDMA Hard Drive[1]
8X DVD-ROM Drive[7]
ATI Mobility M-128 with 16 MB Video Memory
56K ITU V.90 PCI Modem[3]
256 KB Integrated "On-chip" Cache
Integrated 10/100 BaseT Network Port
Microsoft® Windows® 2000 Professional

Personalize by choosing:

15" SXGA+ Panel: Add $150
192 MB SyncDRAM: Add $300
32.0 GB (5400 rpm) UltraDMA Hard Drive[1]: Add $350

JET SETTER

PRESARIO 1700T-750

$2399‡

As low as $67 per month†

Intel Pentium III Processor, 750 MHz,
featuring Intel SpeedStep Technology
14.1" TFT Active Matrix Display
128 MB SyncDRAM
10.0 GB UltraDMA Hard Drive[1]
8X DVD-ROM Drive[7]
ATI Mobility Hardware Accelerated 3D Graphics
with 8 MB Video Memory
56K ITU V.90 PCI Modem[3]
Hi-Capacity LiIon Battery
256 KB Integrated "On-chip" Cache

Personalize by choosing:

Presario University Learn On-line: Add $79/year
CD-RW Drive[4]: Add $150
20.0 GB UltraDMA Hard Drive[1]: Add $200

Includes Windows® Millennium Edition — the home version of the world's favorite software.

[1]All prices shown are Compaq Direct selling prices and do not include monthly Compaq.net service fees, applicable sales tax, and shipping, are valid in the U.S. only, and are subject to change or cancellation without notice. Illustrations may not accurately represent exact configurations priced. Retail pri
for Compaq purchases billed directly to your account. However, there is an access check fee of 3% of the U.S. Dollar amount of each advance check ($5 min./$30 max.). ‡‡**Compaq.net powered by MSN™ Promotions** with purchase of a qualifying Compaq Presario personal computer between 7/1/0
notebooks.) **Both promotions require:** (1) a valid major credit card; (2) a purchase receipt; and (3) acceptance of the Compaq.net Internet Access member agreement. **If you do not continue as a member for the required period of time, you will be required to pay MSN a termination fee**
sign up for a new account, 36-month membership to Compaq.net powered by MSN Internet Access at $21.95 per month plus applicable taxes. **6 Months Free Promotion requires:** sign up for a new account, 12-month membership at $21.95 per month (plus applicable taxes) for the 7th through 12
personal non-commercial use. Local market network activity and capacity may affect access availability. Local phone and/or long distance toll charges may apply. It is your responsibility to check with a local phone company to determine if access numbers are local. See store for additional details. *Cor
for purchases made between 6/4/00 and 1/31/01 while supplies last. Please allow 6 to 8 weeks for delivery. To qualify, you must be a legal U.S. resident 18 years of age or older. Void where prohibited or restricted by law. Compaq reserves the right to modify or withdraw this promotion at any time. See c
K56flex- or V.90-compliant digital sources. Maximum achievable download transmission rates are currently unknown, may not reach 56 Kbps, and will vary with line conditions. [4]CD-RW drive data transfer rates may vary as follows: for recording to CD-R media, the data transfer rate may vary from 1
[5]24X Max CD-ROM data transfer rates may vary from 1500 to 3600 Kbps. [7]8X DVD-ROM drives read a minimum of 4463 Kbps and a maximum of 10820 Kbps. [8]Free Y@P Internet Phone with purchase of a Presario 7000T between 9/10/00 and 11/11/00. Microsoft® Windows® Millennium Edition inst
are trademarks, of Intel Corporation. Microsoft, MS, and Windows are registered trademarks, and MSN is a trademark, of Microsoft Corporation. Products and company names mentioned herein may be trademarks and/or registered trademarks of other companies. Call Compaq Monday–Friday, 7:00an

Copyrighted material

FAMILY CHAMPION

PRESARIO 5000T-733

$1199‡

As low as $34 per month†

Intel Pentium III Processor, 733 MHz
64 MB 100 MHz SyncDRAM — up to 11 MB Shared for Video
10.0 GB UltraDMA Hard Drive[1]
40X Max CD-ROM Drive[5]
8X CD-RW Drive[4]
2X AGP with 64-bit Hardware Accelerated 3D Graphics
56K ITU V.90 Modem[3]
ESS Allegro Integrated PCI Audio
JBL Platinum Speakers with Digital Audio Port
Compaq CV535 15" Monitor (13.8" VIA)

Personalize by choosing:

Y@P Internet Phone: Add $54
Compaq CV735 17" Monitor (16.0" VIA): Add $70

WEB SURFER

PRESARIO 5000T-667

$899‡

As low as $26 per month†

Intel Pentium III Processor, 667 MHz
64 MB 100 MHz SyncDRAM — up to 11 MB Shared for Video
10.0 GB UltraDMA Hard Drive[1]
40X Max CD-ROM Drive[5]
2X AGP with 64-bit Hardware Accelerated 3D Graphics
56K ITU V.90 Modem[3]
ESS Allegro Integrated PCI Audio
JBL Platinum Speakers with Digital Audio Port
Compaq CV535 15" Monitor (13.8" VIA)

Personalize by choosing:

Y@P Internet Phone: Add $54
20.0 GB UltraDMA Hard Drive[1]: Add $60
Compaq CV735 17" Monitor (16.0" VIA): Add $70

SPECIAL OFFERS

GET A $400 REBATE OR 6 MONTHS FREE INTERNET SERVICE

Sign up for Compaq.net powered by MSN™ for 36 months, and get a $400 rebate. Or get 6 months free when you sign up for 12 months of Compaq.net.[11]

PICK YOUR FAVORITE COLOR

Change the color of your PC with a MyStyle Accent Kit. Choose from Sapphire Blue, Amethyst Purple, Ruby Red, Emerald Green, or Amber Orange. FREE* with purchase of select Presario PCs.

— Desktop only

Desktop & Notebook Colors

MUSICIAN

PRESARIO 1400T-600

$1999‡

As low as $56 per month†

Intel Pentium III Processor, 600 MHz
13.3" TFT Active Matrix Display
64 MB SyncDRAM
6.0 GB UltraDMA Hard Drive[1]
CD-RW Drive[4]
Trident CyberBlade Hardware Accelerated 3D Graphics
56K ITU V.90 PCI Modem[3]
Ultra Hi-Capacity LiIon Battery
256 KB Integrated "On-chip" Cache
UBS External Floppy Drive
MyStyle Accent Kit

Personalize by choosing:

Presario University Learn On-line: Add $79/year
128 MB SyncDRAM: Add $200
iPAQ Personal Audio Player: Add $249.99

WEB SURFER

PRESARIO 1200T-566

$1099‡

As low as $31 per month†

Intel Celeron™ Processor, 566 MHz
12.1" HPA Display
64 MB SyncDRAM
5.0 GB UltraDMA Hard Drive[1]
24X Max CD-ROM Drive[5]
Trident CyberBlade Hardware Accelerated 3D Graphics
56K ITU V.90 PCI Modem[3]
NiMH Battery
128 KB Integrated "On-chip" Cache

Personalize by choosing:

Presario University Learn On-line: Add $79/year
96 MB SyncDRAM: Add $100
iPAQ Personal Audio Player: Add $249.99

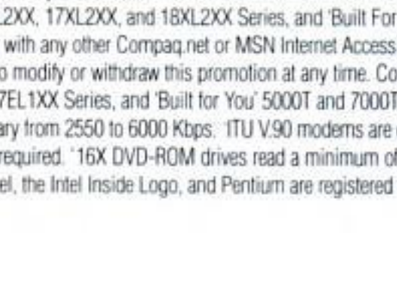
SPOTLIGHTS

LET US BUILD A PC FOR YOU

Choose your processor speed, hard drive, memory, and more. Then add options like digital imaging capabilities, DVD-ROM, and multimedia speakers. Just call us or visit our Web site.

Y@P: YOUR ALTERNATIVE PHONE

The Y@P Phone is an innovative new way to make long distance calls right over the Internet. It's easy to use, and it will significantly lower your phone bills[11].



as may vary. Compaq is not liable for editorial, pictorial, or typographical errors in this advertisement. †Financing on approved credit by arrangement with Compaq Financial Services through MBNA America Bank, N.A. Payment based on a 48-month term at 14.99% APR. Your APR may be higher. There is no fee s and 12/31/00. Offer not available at all Compaq Retailers; check store for availability. (Qualifying models: Presario 5BW1XX and 7AP1XX Series and 'Built For You' 5000T and 7000T Series desktops. Presario 14XL2XX, 17XL2XX, and 18XL2XX Series, and 'Built For You' 1200T, 1400T, 1700T, and 1800T Series **qual to 70% of the monthly service fee multiplied by the number of months requiring payment remaining in your membership period.** These promotions may not be combined with each other, or with any other Compaq.net or MSN Internet Access promotion. **Compaq.net Rebate requires:** n months. For new Compaq.net members, no termination fee will apply if you cancel your membership during the first month. Available only to U.S. residents 18 years or older. Compaq and MSN reserve the right to modify or withdraw this promotion at any time. Compaq.net Internet Access is available only for saq MyStyle Accent Kit introductory mail-in offer (plus shipping & handling $7.95) valid only with purchase of the following Compaq Presario PCs: 1400 Series, 5CA1XX Series, 5BW1XX Series, 7AP1XX Series, 7EL1XX Series, and 'Built for You' 5000T and 7000T Series models (one color per kit). Offer valid upon, retailer, or www.compaq.com/athome/color. Questions? Call 713-300-3053. ††For call rate information, visit www.yapgear.com. ‡For hard drives, GB=billion bytes. ²40X Max CD-ROM data transfer rates may vary from 2550 to 6000 Kbps. ³ITU V.90 modems are designed only to allow faster downloads from t to 600 Kbps; for writing to CD-RW media, the data transfer rate may vary from 150 to 300 Kbps; for reading to CD media, the data transfer rate may vary from 1500 to 3600 Kbps. An appropriate license may be required. ⁵16X DVD-ROM drives read a minimum of 5545 Kbps and a maximum of 21640 Kbps. eed. iPAQ is a trademark of Compaq Information Technologies Group, L.P. Compaq, the Compaq Logo, and Presario are registered in the U.S. Patent and Trademark Office. Y@P is a trademark of Net2Phone Inc. Intel, the Intel Inside Logo, and Pentium are registered trademarks, and Celeron and Intel SpeedStep t-11:00pm (CT). Saturday and Sunday, 7:00am–7:00pm (CT). ©2000 Compaq Computer Corporation. All rights reserved. 6358/11/00

Copyrighted material

MAXIMUM PC SPECIAL ISSUE

FALL 2000

PowerUser HANDBOOK

Overclock Your CPU

Boost your PC by up to 150MHz

Bend Windows to Your Will

Supercharge your OS with our expert tips

Upgrade With Authority

Part-by-part guide to building a better machine

Tear Into Your PC!

The ultimate guide to tweaking and upgrading

imagine MEDIA WITH PASSION

$9.99 U.S./$11.99 CANADA

53>

0 09281 03353 0

DISPLAY UNTIL JANUARY 15, 2001

PLUS 30 PAGES OF HARDCORE HOW-TOs AND CUTTING-EDGE TECH REPORTS

Copyrighted material

Presario 7000T-933 Internet PC
Featuring Intel® Pentium® III Processor

Presario 1700T-750 Internet Notebook PC
Featuring Intel® Pentium® III Processor

Copyrighted material

Break on through to your other side.

You've always known you had a creative side. Or maybe you have a practical side. Or even an entrepreneurial side. Compaq can help you explore all of them, with a wide range of innovative technology designed to make whatever you want to do, easier. Like ultrathin, ultracool notebooks for your adventurous side. Powerful desktops for your energetic side. And the latest Intel® Pentium® III processors for your competitive side. Plus, every one comes pre-loaded with Compaq.net powered by MSN.™‡ Choose one of the PCs here, or let us build one to your exact specifications. It could be just the break you've been looking for.

One of the Presario PCs inside is right for you. Take a look.

Buy direct from Compaq.
Call toll free 1-888-228-6812
compaq.com/athome

COMPAQ

intel inside
pentium® III

This One
LZFT-39X-NGD7
Copyrighted material

The world's largest PC manufacturers buy our memory direct.

[*Genius.*]

Buy your memory direct from one of the largest memory manufacturers in the world. Performance, reliability, selection *and* factory-direct savings — Crucial Technology, a division of Micron.

I ordered my memory yesterday and am up and running today! Super service, super product, and outstanding Web site! I will recommend Crucial to anyone!!!

Jim McClintock, Taynik Consulting

Compare the Savings . . .

64MB Upgrades

Compaq	Kingston	**Crucial**
Presario 5304	$126.00	$71.99
Presario 5070	$126.00	$71.99
Presario 5360	$126.00	$71.99
Micron Electronics	Kingston	**Crucial**
Millennia 400	$115.00	$71.99
Millennia 450	$115.00	$71.99
Millennia MAX 450	$115.00	$71.99
Gateway	Kingston	**Crucial**
G6-450	$115.00	$71.99
G6-400	$115.00	$71.99
Performance 450	$115.00	$71.99
IBM	Kingston	**Crucial**
Aptiva (2153) Model E2U	$111.00	$71.99
Aptiva (2139) Model E5D	$111.00	$71.99
HP	Kingston	**Crucial**
Pavilion 4530	$126.00	$71.99
Pavilion 4535	$126.00	$71.99
Kayak XU PC Workstation 440BX Chipset	$143.00	$89.99
Vectra VL Series 8	$111.00	$71.99
Apple	Kingston	**Crucial**
iMac (G3-350)	$117.00	$71.99
Power Mac G3 PC100	$117.00	$71.99
Power Mac G4	$121.00	$71.99

Crucial prices reflect an automatic 10% discount for ordering online. Prices were taken from Crucial and Kingston Web sites on 8/31/00; however, they can (and do) change daily. Prices may vary according to specific system requirement.

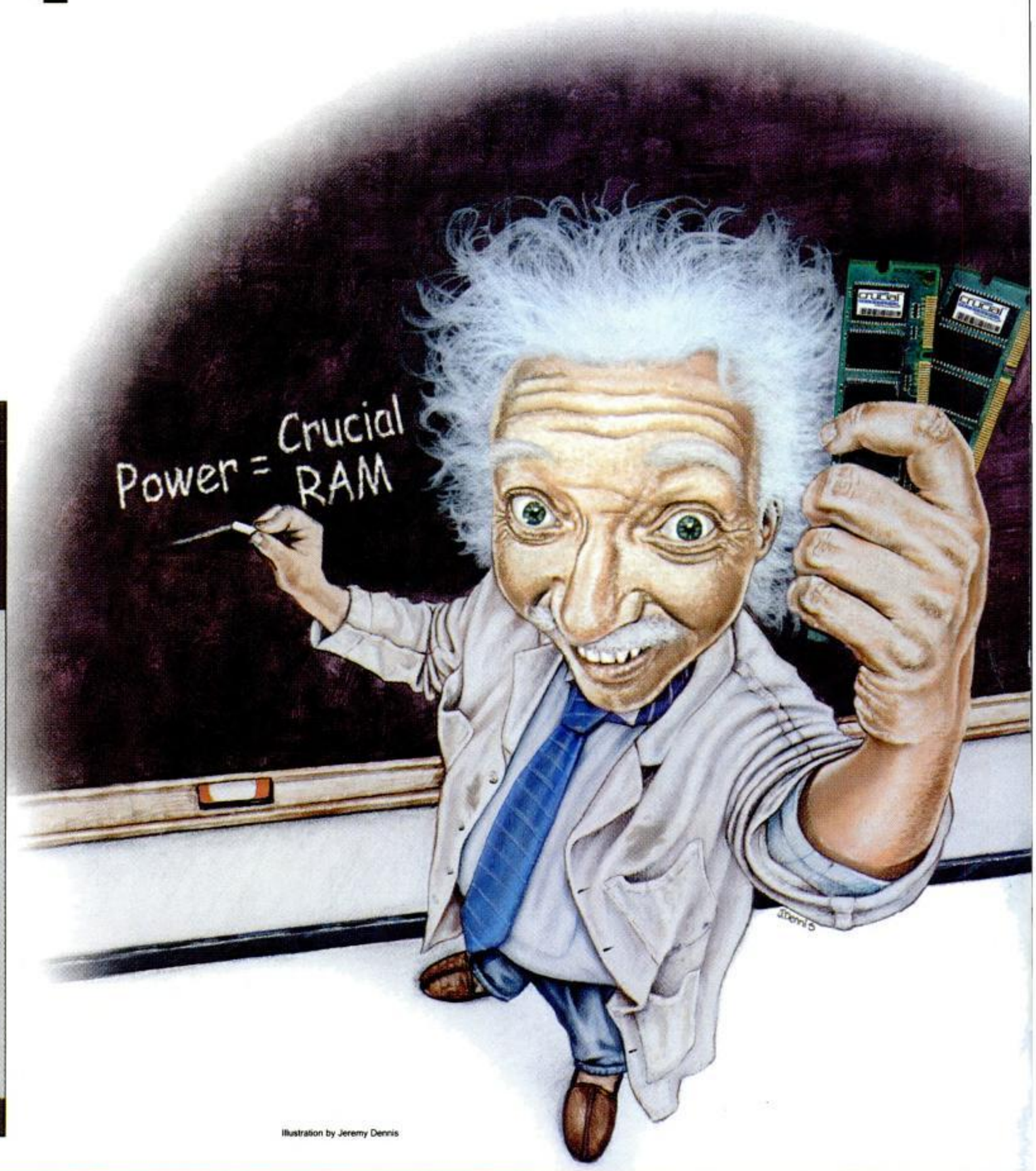


Illustration by Jeremy Dennis

Online discounts for over 42,000 upgrades at:

www.crucial.com/mpc

or call toll free 1-888-363-5154

crucial® TECHNOLOGY
A Division of Micron®

The memory experts.

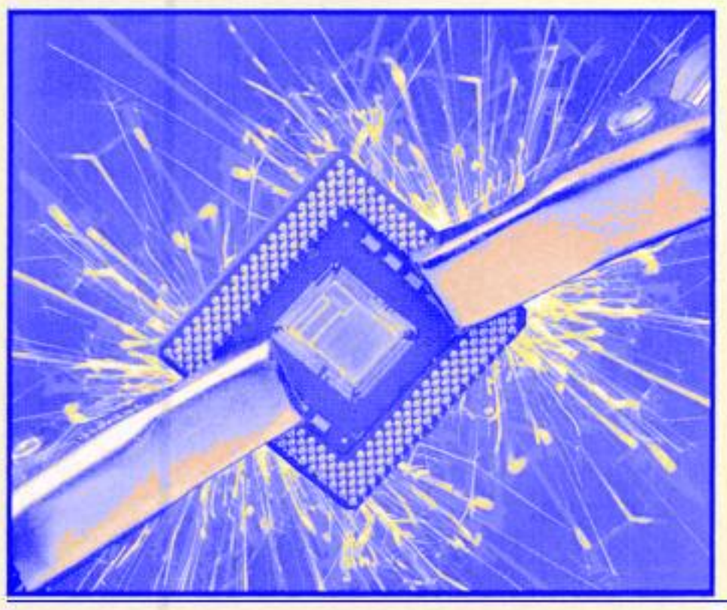
Copyrighted material

©1999 Micron Semiconductor Products, Inc. All rights reserved. Crucial Technology is a trademark of Micron Technology Inc., and Micron is a registered trademark of Micron Technology, Inc. Crucial Technology is not responsible for omissions or errors in typography or photography. All other brands and names used herein are the property of their respective owners. Crucial Technology, a division of Micron Semiconductor Products, Inc. Phone 208-363-5500 Fax 208-363-5501. E-mail crucial.sales@micron.com

MAXIMUM PC SPECIAL

PowerUser HANDBOOK

FALL 2000



14 Overclock

26 System Tips

42 Upgrade Bible

FEATURES

14 Operation: Overclock

Unleash your inner clockspeed and turn your sissy-boy 650MHz CPU into a 700MHz power-lifter. Four case studies describe how to overclock everything from a 300MHz Celeron to a 933MHz Pentium III. Of course, before you toss your silicon into the fire, you need to give it some sweet coolin' with one of the heatsinks that we put on ice.

26 Christen Your System

Whack your PC upside the head with a bottle full of kick-ass. Whether you've just bought a new box or want to breathe new life into an old PC, we've got the lowdown on how to do it. Our 30 system-christening performance tips are designed to maximize your machine's speed potential and bend Windows to your will.

34 Enter the BIOSphere

We went to the BIOS manufacturers to decipher every arcane PC BIOS setting possible. Besides telling you what each switch does what, we show you how to tweak your BIOS to increase your PC's stability and keep it running at peak performance.

42 Upgrade Bible

You don't have to get a new PC when replacing a few parts will get you closer to computing nirvana. Part-by-part, we separate the stong from the weak and provide you with all you need to know to upgrade your PC wisely. Thou shalt covet hardware upgrades that grant your PC a long and prosperous life.

COVER PHOTOGRAPHY BY AARON LAUER

TECH FILES

50 Faster Net Access

Speed up your Internet connection with our complete how-to guide. We walk you through giant leaps and a few baby steps that'll have you racing online.

56 Share your Bandwidth

Whether you're pulling data from a 56k modem or 1Mbps DSL line, it's always nice to share your pipe. Get the full skinny on how to get multiple PCs online with a single Internet connection

60 Inside the Athlon

Get up close and personal with AMD's Athlon as we follow each tock to figure out what makes it tick. We track an instruction through the CPU's innards, from MacroOPs to execution units.

63 Motherboard Buses

Fly the friendly skies of your motherboard with our lowdown on the routes your data travels and the buses that get it there.

66 Inside the GeForce 2

How does all that raw game data get translated into gorgeous texture-mapped polygons? Dive into the GeForce 2's architecture to find out.

69 3D Vocabulary

Without the right vocabulary, you'll never know why your videocard should support a "32-bit z-buffer." Learn to speak 3D while you take a visual tour of what 3D effects actually look like.

75 How Monitors Work

A behind the screens look at the intricate electronics involved in dazzling your peepers with vibrant pixels. Monitors may seem simple, but inside the case there's more going on than will ever meet the eye.

79 Identify Hardware

Parts are not just parts. Learn how to identify all the old computer components that are sitting in your discards box—their hidden marks tell a fascinating story.

83 Chipset Fieldguide

Motherboard chipsets are getting more and more confusing. BX, i820, KX133—If you can't make sense of this alphabet soup, learn some chipset shop talk.

87 All About RAM

With so many varieties of memory available, it's getting to the point where buying RAM is as complex as getting a new videocard. Peruse this fieldguide before your next upgrade.

VOICES

6 Ed Word

High-powered equipment does not a power user make. Sean Downey lays down the law on pure PC power.

10 Ask the Doctor

You've got PC problems and we've got answers. Isn't it nice how that works?

Copyrighted material

IMAGINE IT.

MEMORY STICK 64MB

SONY

STICK IT.™

If the world of digital has become your world, Memory Stick® media is the link that sticks it all together. You can capture digital images and MPEG video. You can store digital music files. And with the Sony Memory Stick Voice Recorder, you can even record your voice and convert it to text. That's just the beginning.

Imagine the possibilities at www.sony.com/MS

MEMORY STICK

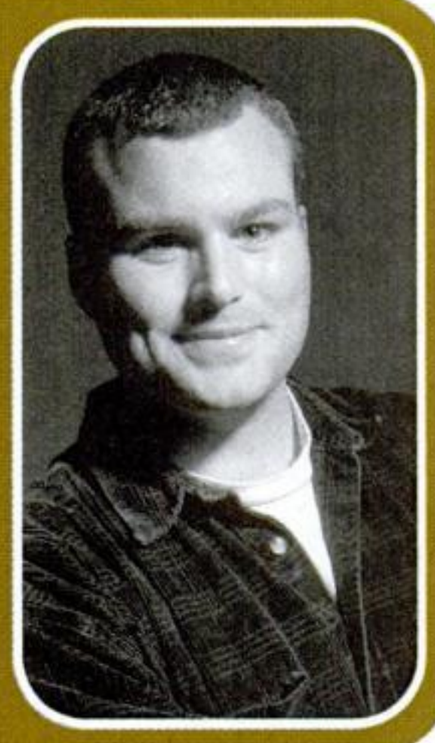
MS Walkman® personal stereo requires MagicGate® Memory Stick® media.

©2000 Sony Electronics Inc. All rights reserved. Reproduction in whole or part without written permission is prohibited. Sony, Memory Stick, Memory Stick Walkman, MagicGate, and *Stick It* are trademarks of Sony Corporation.

Copyrighted material

EdWord

Pure PC power is only in your mind



Face facts—you'll never have the perfect PC. Entropy and engineers in the thousands are conspiring against you. That pristine box of wires, cables, and printed circuit boards under your desk will dissolve into a disordered mess of sluggish apps and outdated hardware before you ever reach your ideal of PC perfection. No OS is bulletproof, no software is ever completely finished, no driver is 100 percent stable, and no hardware is ever an end-all, be-all engineering masterpiece. Just when you've finished assembling the fastest rig on your block, some laboratory poindexter will invent a technology that makes your CPU, video-card, or hard drive run twice as fast for half the cost.

If you want to get the most out of the hardware you've got, you need to be informed. Whether your PC is constantly in pieces or untouched on a pedestal, this collection of technical white papers, how-tos, and in-depth features is geared to supply you with everything you need to know to get the best performance from your machine. Within these pages, you'll find the collected knowledge of two years of *Maximum PC* magazine. From exploring how data moves around your motherboard to explaining how to speed up your Internet connection, each article has been updated and digitally remastered to keep current with new technological developments.

The Power User Handbook isn't a drab textbook on how a computer works, but a dynamic snapshot of the current state of PC hardware.

The ambitious concept behind every article in this collection is to take engineer-level concepts and explain them in an entertaining way that's easy to understand.

I've had the privilege of working with many editors at *Maximum PC* and *boot* magazine over the past four years, and all of them have impressed upon me their knowledge and passion for all things PC. Month in, month out, they put together a magazine that's packed with the most comprehensive product coverage and hardcore articles on everything that makes your PC purr. As you can see from all the web sites that have unsuccessfully imitated *Maximum PC*, this isn't an easy thing to do. Compiling a collection of the best "power user" articles for this special issue hasn't been an easy task.

While the term "power user" is used to describe anything from the hax0r l33t to someone who knows how to change the point of view in *Quake III*, it really only applies to the individuals who know (or are willing to learn) all about their hardware and have the wherewithal to apply that knowledge. Anyone with a huge wad of cash can take home a brand-spankin' new 1GHz monstrosity stocked to the gills with all the latest and greatest parts, but only a true power user will know how to make the most of a rig this powerful. When it comes to PCs, it's not the megahertz in the machine but the knowledge in your noggin that results in pure PC power.

For my personal definition of power user, I always think of senior editor Andrew Sanchez. During the time I worked with him, I learned that nothing is so mind-numbingly intricate that it can't be described with a style and humor. While he didn't constantly tweak his PCs, he managed to bring each one to its knees with his constant use. When he passed away on February 6, 1999, he took with him so much promise, passion and knowledge. He was by far the greatest power user I've ever known.

"... only a true power user will know how to make the most of a rig this powerful."

PowerUser HANDBOOK

fall2000 SPECIAL

EDITORIAL
Sean Downey editor-in-chief
Kristen Shepos-Salvatore managing editor
Chris Dunphy senior technical editor
Will Smith technical editor
contributing writers Jon Phillips, Gordon Mah Ung, Josh Norem, Geoffrey Visgilio, Scott Tarr, Jon Stokes, Lenny Bailes, Fabian Echevarria, Devin Charters, Sean Cleveland
Kenn Durrence disc editor
Andrew Sanchez editor emeritus

ART
Wayne Allen art director
contributing photographers Aaron Lauer, Jack Hutcheson
contributing illustrators XPLANE

PRODUCTION
Richard Lesovoy production director
Eric O'Connell production coordinator

ADVERTISING
SAN FRANCISCO
Chris Coelho publisher
Bernard Lanigan eastern advertising director
Nancy Romano regional sales manager
Sharon Kiernan marketplace manager
Alison McCreery marketing coordinator
Renata Scantlin advertising coordinator
Doug Haynie advertising coordinator
DIGITAL ADVERTISING
Rudy Tabasa director of sales
Kelly McNamara eastern sales manager
Darren Glidden regional sales manager

CIRCULATION
Stephanie Flanagan subscription director
Erik Alekman newsstand director
Peggy Mores senior fulfillment manager
Mary Firme online marketing manager
Nicole Patterson direct marketing specialist

REPRINTS
PRINT AND DIGITAL
Reprint Management Services 717.399.1900

imagine MEDIA WITH PASSION

Imagine Media, Inc.
150 North Hill Dr. Brisbane, CA 94005
(415) 468-4684 www.imaginemedia.com

Executive Chairman • Chris Anderson
Vice President/CFO • Tom Valentino
Vice President/Circulation • Holly Klingel
Vice President/Human Resources • Steve Leibman
General Counsel • Charles Schug

IMAGINE BUSINESS DIVISION:
(Business 2.0)
President • Michela O'Connor Abrams

IMAGINE COMPUTING DIVISION:
President • Cheryl England
(MacAddict, Maximum PC, Maximum Linux)

IMAGINE ENTERTAINMENT DIVISION:
President • Jonathan Simpson-Bint
(PC Gamer, PSM, PC Accelerator, Next Generation, Games Business)

Imagine Media is aimed at people who have a passion. A passion for games. For business. For computers. Or for the Internet. These are passions we share. Our goal is to feed your passion with the greatest magazines, web sites, and CD-ROMs imaginable. We love to innovate, we love to have fun, and we have a cast-iron rule always to deliver spectacular editorial value. That means doing whatever it takes to give you the information you need. With any luck, we'll even make you smile sometimes...Thanks for joining us.

the future network
Media with passion

Imagine Media is part of The Future Network plc.

The Future Network serves the information needs of groups of people who share a passion. We aim to satisfy their passion by creating magazines and web sites that offer superb value for money, trustworthy information, multiple ways to save time and money, and are a pleasure to read or visit. This simple strategy has helped create one of the fastest-growing media companies in the world: today we publish more than 130 magazines, over 45 magazine web sites and eight specialist web networks from offices in seven countries. The company also licences 52 magazines in 26 other countries.

The Future Network plc is a public company quoted on the London Stock Exchange (symbol: FNET).

Copyrighted material

Actual game footage

Racing is in your blood

Along with small pieces of rock and bone.

Satisfy your craving for dirt-bike action, head-numbing crashes and outrageous stunts on over 40 tracks in 6 events including Stunt Quarry, Nationals, Baja, Enduro, Supercross and Multi-player Tag, and get that blood of yours pumping. Download the free trial version of Motocross Madness 2 at www.microsoft.com/games/motocross2

rainbow STUDIOS

EVERYONE E CONTENT RATED BY ESRB

msn Gaming ZONE

HONDA Official Licensed Product

KTM SPORTMOTORCYCLES

YAMAHA

Microsoft

© 2000 Microsoft Corporation. All rights reserved. Microsoft and Motocross Madness 2 are either registered trademarks or trademarks of Microsoft Corporation in the U.S. and/or other countries. YAMAHA is a registered trademark and is used with permission of Yamaha Motor Co., Ltd. HONDA®, the Wing® logo, CR®, XR™ and the distinctive likenesses of its motorcycles are owned by HONDA MOTOR CO., LTD. and licensed by AMERICAN HONDA MOTOR CO., INC. in the U.S. The KTM Trademarks are used by Microsoft with express written permission of KTM Sportmotorcycle USA, Inc.

Copyrighted material

24X
AUDIO RIP

Rip a 3-minute song from a CD in less than 8 seconds with 100% accuracy, no clicks or pops.

12X
WRITE

Burn a full CD in just 6 minutes. Converts MP3/WAV audio play lists automatically into play anywhere CDs.

THE FAILSAFE™ CHOICE FOR CD RECORDING

10X
REWRITE

32X
READ

Backup data and share projects faster and more convenient than any other storage device.

AT LAST, A CD BURNER THAT LETS YOU RUN MULTIPLE APPLICATIONS AND RECORD AT THE SAME TIME. THE KEY IS TDK FAILSAFE TECHNOLOGY, AND VELOCD HAS IT. WITH FAILSAFE, BUFFER UNDERRUN ERRORS ARE ELIMINATED. THAT MEANS NO MORE CD COASTERS. JUST SWEET RECORDING PERFECTION.

INTERNAL
ATAPI / EIDE
CD-REWRITABLE DRIVE

TDK®

Copyrighted material

velocd

80 MINUTE READY

Mix your music and develop your Sweetspot for digital audio recording: www.velocd.tdk.com.

Copyrighted material

Ask the Doctor

When you've got a burning PC question about your PC, e-mail doctor@maximumpc.com and we'll bust out the stethoscope.

Clock-locks and shut downs

I recently purchased a Micron PC with a 667MHz Pentium III, a Tyan S1854 motherboard running the VIA Apollo 133A chipset, and Windows 98 Second Edition. Do you know how I can turn off that portion of the Power Management that forces the computer to completely turn itself off after Windows is shut down?

My second question relates to overclocking. The multiplier on my system is set to 5.0 on a 133MHz bus, giving the CPU its 667MHz speed. However, I see that the multipliers on this motherboard go up to 7.0, indicating that with the proper cooling, the P-III could be taken to 931MHz. I've heard conflicting reports about the P-III's ability to be overclocked; I've read that some are "locked" into a clock frequency and can't be overclocked, and some are not. How do I know if mine is locked or not? I wouldn't mind a little bump to 798MHz by utilizing the 6.0 multiplier. What say you?

—Dave Olshina

To get your PC into "safe to turn off your computer" mode, disable all advanced power management features in both the BIOS and in Windows. In the BIOS, go to the advanced power management screen and change the setting to "disabled." In the Win98 Control Panel, go to System Properties>Device Manager>System Device>Advanced Power Management. Click "disable in this hardware profile," and you'll be all set.

As for your other query, you shouldn't be able to overclock your CPU to 800MHz because it should be clock-locked, meaning the 5.0 multiplier is set in the chip. Some people report that their P-III CPUs aren't clock-locked, but they're either lying or lucky, since a non-locked CPU showing up in retail is a verified anomaly. Still, we can believe that a few not-clock-locked ones have slipped through. If your CPU says "Intel confidential" on the casing, it's probably not locked.

The only way to overclock locked P-IIIs is to adjust the frontside bus speed. If your BIOS and motherboard allow bus speed increases, experiment with various settings in search of a stable speed. If they don't, download SoftFSB from www.h-oda.com and adjust your FSB manually. But don't blame us if you burn your house down or ruin your PC.

Bogged Down Bootup

I've cleared everything from the Startup folder and the Run key in my Registry, but I can't seem to reduce the time it takes for my PC to boot. It currently takes four or five minutes to boot my system! I have a 366MHz Celeron, 128MB of RAM, a 45GB hard drive, and plenty of peripherals. Could you please tell me how I can speed things up at startup?

—David Gautraud

Windows may not be responsible for the amount of time it takes your PC to startup. Some hardware is notorious for prolonging the bootup process. If your system takes longer than a minute or two to boot, there's a very good chance it's due to obstinate hardware, especially when a large portion of the boot process is spent before the Starting Windows screen pops up. SCSI cards, Ultra DMA controllers, RAID cards, and some soundcards just take a long time to initialize. If you have IDE drives, you can shave a few seconds off your boot time by pre-detecting the drives in the BIOS, rather than forcing your PC to detect them each time you restart. Look for IDE Drive Auto-configuration in your motherboard's manual for more details.

Wherefore art thou, AGP 4x?

I hear a lot about AGP 4x, but not many boards list this spec about their AGP port. Can you recommend a good BX board that supports this along with UltraDMA/66? And will I gain a big difference by having AGP 4x support for my GeForce?

—Steve Rodgers

Unfortunately, because Intel's BX chipset was released when AGP 2x was still brand-spanking-new technology, it didn't include support for some of the newer interfaces, such as AGP 4x and Ultra DMA/66. You aren't going to find a BX board with AGP 4x or UDMA/66 integrated in the chipset. However, you do have lots of choices if you want to upgrade to a board with a more advanced chipset.

If you want AGP 4x support and dig Intel processors, there are basically three motherboard chipsets to choose from: the Via Apollo Pro 133A, Intel's 820, or the new i815. All three support a 133MHz system bus, AGP 4x, and UDMA/66, and supply the correct voltages for Coppermine Pentiums. The only important difference between these chipsets is that the Apollo Pro 133A and i815 support 133MHz SDRAM, while the i820 requires Direct RDRAM for maximum performance—and Rambus RIMMs are really expensive. 128MB of RDRAM is about five times as expensive as 128MB of PC133 SDRAM. Wowsa!

The bad news is that upgrading just your motherboard may not actually provide you with a performance increase worth the expense and hassle. While more bandwidth is always better, very few games out right now are capable of taking full advantage of the AGP 2x bus. If you're feeling an uncontrollable urge to upgrade something, we usually recommend you grab either a faster processor to go with that new mobo, or a new videocard. Since your GeForce is still pimpalicious, we suggest that you get a new processor that lets it shine.

> **Some hardware is notorious for prolonging the bootup process.**

Copyrighted material

Divining DSL

My DSL provider is offering three different types of DSL modems: an external using a network card interface, an external with a USB interface, and an internal PCI. Which one will provide the fastest downloads and lowest latency?

—Wendell J. Louis

Well, Wendell, as you pointed out, there are two factors at work here: throughput (or download speed) and latency (the delay between a request and the response). Since every piece of equipment's throughput is measured in different units, it's easy to get confused. We've converted everything to Megabytes/second (MB/sec) to eliminate confusion. Since standard DSL's downstream data rate is only 1MB/sec, it will cause a bottleneck regardless of the interface you choose. A PCI card (with 133MB/sec rate) is fastest, with Fast Ethernet (commonly called 100Mbit Ethernet) a distant second (12.5MB/sec), and USB (1.5MB/sec) and standard 10Mbit Ethernet (1.25MB/sec) bringing up the rear.

Latency, however, is another matter—one that's mostly beyond your control. While the speed of your connection does affect latency, your ISP's connection to the Internet backbone, the distance to the server you're connecting to, the current load on that server, and whether someone in Reston, VA got overanxious with a backhoe that day can make a much bigger difference than the connections within your PC.

There are some other things to consider. With most USB or PCI DSL modems, driver support is limited to Windows. If you have dreams of running Linux or BeOS and having a net connection, the modem with the network card interface is the only way to go. While BeOS and Linux driver support may be lacking for DSL modems, many network cards that are supported by both OSes.

If you consider the new routers specifically designed to connect multiple computers to a DSL or cable modem via an Ethernet connection, the decision is all but made for you. Ethernet is the only way to go.

Your CPU's performance doesn't drop to accommodate a slow hard drive. In fact, a fast CPU can lessen the impact of a slow hard drive.

How S.M.A.R.T. is my drive?

How does S.M.A.R.T. work? Is there a utility you can run under Windows that monitors the status of your drives?

—Kevin Post

S.M.A.R.T. technology was developed in 1995 by Quantum, with the goal of increasing hard drive reliability by attempting to predict future device failures. S.M.A.R.T.—Self Monitoring, Analysis, and Reporting Technology—works to detect problems using internal sensors and software that's installed on the drive. The drive software monitors the internal performance of the drive's motors, media, heads, and electronics, while the external software monitors the overall reliability status of the drive. Reliability status is determined by analyzing the drive's internal performance level and comparing it with predetermined threshold limits. If a problem is uncovered, a BIOS warning is sent to the user, who hopefully has enough time to do a data backup. Of course, S.M.A.R.T. can't predict all future device failures, so it should be used las a safety device, not a tool to predict device reliability. Programs such as Norton Utilities will keep your disk's health in check at all times, but that kind of background monitoring consumes valuable system resources and can degrade system performance.

Boat Anchor or Hard Drive?

I'm considering an upgrade to a 500MHz Pentium III, but a friend of mine told me that I don't need a CPU faster than 333MHz because hard drive speeds haven't kept up with the advances in processor speeds. He says any processor faster than a 333MHz Pentium II won't improve performance because the processor is waiting on the hard drive to relay data.

Is this true?

—Michael Lee

A computer's hard drive always processes data much more slowly than the CPU, but your friend's misinformed advice doesn't take into account how computers actually work. The CPU is a ravenous number-crunching crunching machine that's constantly looking for new data to chew on. When it runs out of data, it first looks for fodder in high-speed cache—L1, L2, or L3 cache. If it can't find the appropriate pieces of data in cache, it turns to slower system memory. If it has no luck there, it finally turns to the hard drive, the slowest link in the data chain.

Your CPU's performance doesn't drop to accommodate a slow hard drive. In fact, a fast CPU can lessen the impact of a slow hard drive. And, in general, it's a good idea to always go with the fastest possible components in every phase of your processing chain. The sole exception is your videocard: Sometimes your CPU can't feed triangles quickly enough to the graphics processor, and the videocard never realizes its full rendering potential.

Leaky Windows

Whenever I run my PC for any length of time, I can actually feel it slow down. When I look at my System Properties dialog and click on the Performance tab, I see that I usually boot up with about 85 percent of system resources free. About an hour later, it's down to about 60 percent; any longer and it drops below 50 percent and is practically unusable, demanding a reboot. I run many programs simultaneously, including several browser windows, Winamp, and sometimes a graphics app, but does this sound normal?

—Justin Boates

Yes, this is normal for Windows, and it's commonly referred to as "memory leak." Windows 98/ME doesn't dynamically allocate memory for its apps, instead opting for the app itself to determine its needs and then free up the memory it used when the app closes. Memory leaking occurs when an app fails to close out all the system resources it used. Sometimes, Windows itself is responsible for its own memory leakage. Look for the latest version of your applications or for patches that may have fixed problems. A fresh reload of the operating system couldn't hurt either.

Protracted Extraction

I recently installed an HP9100i CD Writer in my 450MHz Dell, which also has an NEC CD-ROM drive rated at 40x. However, when I copy music tracks directly from the NEC drive, the transfer rate maxes out at 4x. Is this the fault of the NEC drive, and if so, what should I replace it with? A Kenwood 72x?

—Anh Nguyen

Your CD-ROM drive is extracting audio at a snail's pace because it's a task your

Whenever I run my PC for any length of time, I can actually feel it slow down.

Copyrighted material

drive wasn't designed to do. In general, variations in the speed of audio extraction are influenced by two factors: the design of your optical drive and the way audio is recorded onto a CD. CD-ROM drives are primarily designed to read data, not audio. Reading data is a breeze, because each data block contains both header and error correction information. The drive's head knows exactly where data is located, so that no errors occur during the read process. Audio, on the other hand, fills the entire block with audio data, and includes no error correction info and no header data.

It sounds like your NEC drive doesn't have the necessary audio alignment features to accurately extract audio. Without any alignment or error correction features, your CD-ROM drive can be off by as much as 75 sectors, or one second of audio playback.

If you think getting a faster drive will solve your problems, you're mistaken. Just because a drive can read data quickly doesn't mean it can accurately locate audio blocks. And just because a drive can locate audio doesn't mean it can extract it at anywhere near the drive's top speed.

For example, Kenwood's 72x True X drive is easily the fastest drive we've seen at audio extraction (it can hit 45x), but unfortunately, the drive has no error correction capability. Nor does it report errors to the software, which slows down the burning process. These two capabilities have to be engineered into a drive, and can't be compensated for with software tweaks.

For the most accurate audio duplication, go with a drive from Plextor or TDK. Both drives include pin-point alignment capability, so the drive can detect on its own whether or not it's reading from the correct location on the disc.

DIMM dilemma

I was wondering whether there's any performance advantage to having a single 128MB DIMM instead of two 64MB DIMMs. Also, does it matter whether the memory is the same brand, as long as it's the same speed? Could different brands of memory in the same system cause losses in performance or make the system unstable?

—Paul Wetter

Two DIMMs will offer the exact same performance as one DIMM, though it's always beneficial to keep a DIMM slot open for future expansion. If you've got several open DIMM slots, feel free to buy either two 64MB DIMMs or one 128MB DIMM; it really doesn't matter.

As for mixing memory brands within a PC, this is very dangerous and is in fact, banned in 19 states. Seriously, mixing brands isn't a big deal, and according to a spokesman from memory maker Kingston, is almost never a problem for desktop PCs. Once in a blue moon, mixing brands could lead to problems, but they're usually associated with varying chip densities or different IC chip manufacturers.

Big in Japan

I'm ready to buy a DVD drive, but I'm moving to Japan in six months. I've heard that all DVD units have a territorial lockout chip that prevents them from reading DVDs from other territories. I really can't afford to buy another DVD drive in Japan, and I may stay there for three years or more.

—Mike Coelho

Great question! Actually, you'll run into more problems on the media than the player side. The Open DVD standard was formulated using the DVD Region Code that uses the Content Scramble System (CSS) copy-protection standard, which divides the world into six regions. Content designated for one region cannot be read by players in another. Along with copy protection, it gives the studios control over how movies are released in different areas of the world. DVD drives don't contain this coding, although MPEG-2 decoders do (both hardware and software).

Many MPEG-2 boards, such as Sigma Design's Hollywood+, let you change the DVD Region Code setting five times. After that that, a "nominal handling charge" is required.

> **Two DIMMs will offer the exact same performance as one DIMM.**

DMA Downfalls

I've checked DMA on both my hard drive and CD-ROM, and the performance when down for me. Games stutter and installs from the CD-ROM take forever, plus I get install errors. Your magazine has suggested that DMA should be checked, but it works better for me without it. To the best of my knowledge, the CD-ROM, hard drive, and motherboard are all UltraDMA-capable. Am I doing something wrong, or should I just leave DMA unchecked?

—Earle D. Zulueta

Enabling the DMA option in Windows doesn't automatically give you UltraDMA. The DMA bus-mastering support that enables IDE devices to bypass the CPU and access data directly from memory (hence the name Direct Memory Access) was introduced before UltraDMA came around. Most EIDE hard drives and ATAPI devices (such as CD-ROM drives should be able to take advantage of Windows DMA support, but if your hardware doesn't work with it you shouldn't panic.

As far as UltraDMA support goes, your problems could just stem from a cheap CD-ROM drive. Since most CD-ROM drives are sent with UltraDMA mode support disabled (for compatibility with older motherboards), you'll need to figure out how to turn it on if you want the higher throughput rates. Enabling UltraDMA usually involves adding or removing a jumper from the back of the drive, but not all documentation explains this. Check the manual and search the web site for the correct jumper setting.

Delvin' Into Kelvin

Concerning monitors, what is the difference between 6500k and 9300k degrees? Which one is better to run at, or does it matter?

—David Conley

David is referring to the Kelvin color temperature options that are made available via most monitors' onscreen controls. Specifically, the controls adjust the subtle color variations in what is represented as "white" on your display. Lower temperature settings will produce a slightly reddish cast in otherwise pure whites, while higher settings produce a bluish cast.

What does color casting have to do with temperatures? Well, the scaling is based on Kelvin heat measurements. Heat up a carbon block to 6000 degrees Kelvin and it will emit a white light with a slightly reddish cast. Keep increasing the temperature, and the white light will take on a bluish cast in the 9300k to 10,500k range. Choosing which temperature to run is a matter of personal preference. Many people prefer lower color temperatures because they offer a "warmer" cast. Play round and choose the temperature that's most pleasing to your eye.

> **Without any alignment or error correction features your CD-ROM drive can be off by as much one second of audio playback.**

Copyrighted material

Ace pilots don't settle for cheap thrills.
Real flying is all about wrestling the raw powers of Mother Nature. Hanging on as you throttle your engines. And relishing the feeling as your wheels kiss the tarmac. You've never felt anything like the new SideWinder® Force Feedback 2 joystick. Using a next-generation processor, it takes technology to the limit by delivering over 100 distinct forces with more speed and strength than ever before. Turning more than 200 force feedback–enabled games into the most intense gaming experience imaginable. So the next time you're ready to push the envelope, you'd better buckle in first.
MICROSOFT
SIDEWINDER
FORCE FEEDBACK 2
www.microsoft.com/sidewinder
© 2000 Microsoft Corporation. All rights reserved. Microsoft and SideWinder are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

Copyrighted material

Operation: Overclock

PUSHING YOUR SILICON TO THE LIMIT

Copyrighted material

Coaxing extra performance from your CPU without paying an extra penny sounds tempting, doesn't it? You can get that performance boost simply by twiddling with your motherboard settings. It's known as overclocking, and it can reset a 300MHz processor to run at 450MHz and beyond.

Thanks to more efficient manufacturing processes, CPUs are running cooler than ever before. This only encourages power users to forge ahead into overclocking, the most taboo of computing subjects. System vendors abhor it, but people are digging the overclocking scene in a serious way. Chipmakers tend not to mind hardcore users who dabble in the dark arts—as long as it's on a personal, CPU-by-CPU basis. The chip makers are much more concerned with unscrupulous dingleberries who overclock CPUs en masse, re-mark them with a higher clock setting, and then sell them at a higher price.

The route to overclocking is fraught with danger and could possibly result in permanent chip destruction. Push any microprocessor past its spec'd speed and it will heat up more than it should. Heat is the numero uno danger for overclockers; it can melt internal circuits and cause all sorts of problems. But, if you're brave enough, read on, and check out our four overclocking case studies. They shouldn't be considered definitive how-to articles, but rather examples of what you can do with specific CPU/motherboard combos. The key is to absorb the general conventions of overclocking and then apply this knowledge to your own rig.

For more overclocking instruction, go to www.maximumpc.com and look for our overclocking articles in the Re:Print section.

In general, all CPU overclocking is accomplished by tweaking either your BIOS or your motherboard's jumper settings to increase the CPU multiplier or system-bus speed (a CPU's speed is determined by the speed of the system bus multiplied by an arbitrary number, aptly called a multiplier). And, of course, one must always prepare for increased CPU heat by installing extra cooling devices. We close out Operation: Overclock with a look at cooling solutions.

A word about our case studies: We were able to adjust bus and multiplier settings through simple motherboard BIOS adjustments. If your BIOS doesn't offer access to these settings, you'll need documentation on which physical motherboard jumpers adjust bus and multiplier values. Please understand: *Maximum PC* is not responsible for any damage or downtime incurred due to overclocking —proceed at your own risk! (All the ill mojo is described in our Meltdown Alerts.)

Overclocking can be the doorway to speed nirvana. But before you start on this journey, you must do two things: 1) Have your motherboard manual handy. If something acts the fool on your system, you won't have Internet access to download the latest help file. 2) Write down all your original motherboard multiplier, jumper, and voltage settings, to ensure you can put everything back to normal in case of mishap.

If you aren't afraid of a little extra power, turn the page and begin working your way towards becoming an overclocking guru.

—Andrew Sanchez and Will Smith

Copyrighted material

coal^{n}

graphics^{n}

Bright, crisp, and fast. NVIDIA graphics processors deliver a level of quality which is unparalleled, letting you get the most out of your Internet, multimedia, and business applications. As a consistent winner of awards like PC Magazine Editors' Choice, and PC World's Best Buy, it's no surprise that the top PC companies like Dell™ and Compaq™ use our processors for everything from basic PC's to professional workstations. **Discover graphics to the nth degree.**

nVIDIA.

NVIDIA and the NVIDIA logo are registered trademarks of NVIDIA Corp. © 2000 NVIDIA Corporation

www.nvidia.com

Celeron 300A

Mission:

Take the much-celebrated Celeron 300A through the bin cycle. This hottie is renowned as one of the most overclockable CPUs. If you don't think you can add 150MHz to it, think again!

STEP 1 With its default configuration of a 66MHz system bus and 4.5 multiplier, this proc's baseline is 300MHz.

STEP 2 After dabbling with an Abit board during our Pentium 200MHz experimentation, we reaffirmed why Abit is the mobo maker of choice among overclocking folk: The BIOS settings within the motherboard's "CPU Soft Menu II" allow you many back doors to speed-increased bliss. With the Celeron 300A, we first tried the old "one bin up" overclocking method by setting the motherboard for an automatic 333MHz (66MHz x 5.0). After rebooting the system, we were greeted with a fat error message complaining the CPU wasn't set correctly, so we went back into the BIOS and manually forced a 66MHz x 5.0 setting. And we got another error. We had just encountered the "multiplier lock protection" that folks have complained about. By forcing this CPU to accept only a 4.5 multiplier, Intel hopes to stifle "one-bin-up" overclockers. Too bad Intel forgot about the system bus!

STEP 3 Leaving the core voltage at the default 2.0 volts, we set the BIOS to configure itself for a 450MHz setting—100MHz x 4.5. Rebooting the system, we got as far as the Win98 boot-up screen before the system coughed up a Blue Screen of Death.

Overclocking a Celeron A this way often requires voltage tweaking to ensure proper power. Time to start fiddling with the voltage settings.

STEP 4 With a 2.05-volt setting, we rebooted the system. Again, it crashed. With a 2.1-volt setting (the unofficial voltage for an overclocked Celeron A), we managed to get into Windows 98 and run some benchmarks, but *Quake II* and *bootMark* locked up the machine after a couple of runs. So we prepared to enter the upper-end of voltage country.

STEP 5 With 2.2 volts humming under the hood, we held our breath and rebooted. No problems posting, and Windows loaded without any errors! Excellent. Benchmarking went off without a hitch—the rig even ran *SYSmark 98* (our most time-consuming benchmark, at two-plus hours) without a problem. As you can see from the test results, an overclocked Celeron A puts out mongo extra performance.

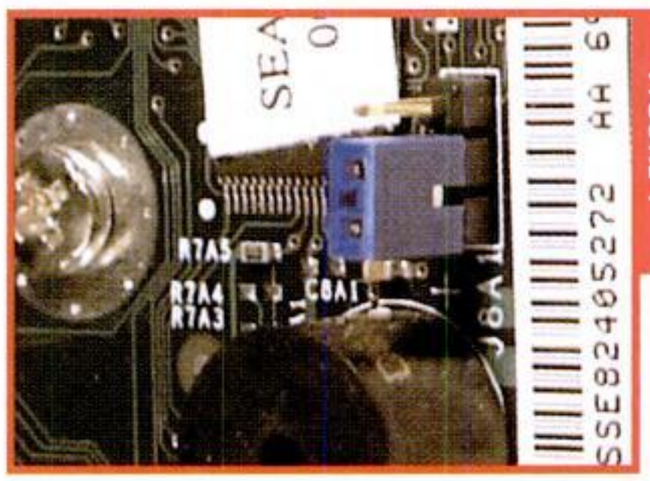
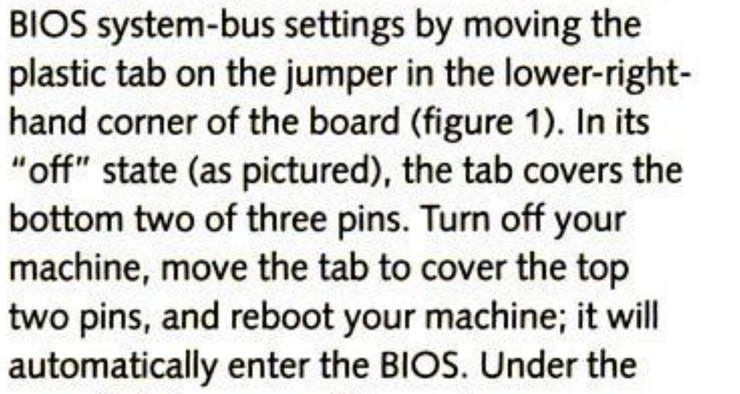


FIGURE 1

Analysis:

With the proper mobo and settings, you can get an extra 150MHz out of a 300A without breaking a sweat. You'll need a 440BX-based board spec'd for a 100MHz bus. The obvious choice would be any of Abit's boards, but if you already have a standard BX-based board, be aware that you can sometimes "evoke" BIOS system-bus settings by moving the plastic tab on the jumper in the lower-right-hand corner of the board (figure 1). In its "off" state (as pictured), the tab covers the bottom two of three pins. Turn off your machine, move the tab to cover the top two pins, and reboot your machine; it will automatically enter the BIOS. Under the new Maintenance settings, change your processor speed appropriately, save changes, turn off your machine, put the tab back over the bottom-two pins, reboot, and enjoy your new speed!

Benchmarks:



SYSTEM CONFIGURATION Celerion 300A, Abit BX6 motherboard ATX (Intel 440BX), 128 MB 100MHz SDRAM, Western Digital hard drive, Sony DVD-ROM drive, STB Velocity 4400 (nVidia TNT with 16MB SDRAM)

MELTDOWN ALERT: Electromigration

Electromigration is the process by which a CPU's circuits break down due to electrical erosion. Just like a raging river cutting through a valley, electricity can actually erode a CPU's circuit paths. Critics say the process is greatly accelerated by overclocking. Advocates argue that even if electromigration cuts the life of a processor in half, you're simply looking at shortening a CPU's life from ten years to five years. And we all know that only a caveman would be caught dead with a five-year old computer. Not even the 486 is five years old! Because death-by-electromigration can only be proved with the help of an electron microscope, most overclockers disregard the hype, and run at a higher speed oblivious to what's happening on the sub-micron level.

Copyrighted material

Pentium II 266MHz

Mission:

Folks bought into the P-II 266 with a passion, so it's only proper that we try to get some extra juice out of the ol' boy. The fabled multiplier lock is a threat with these older P-IIs, so we may encounter some chop.

MELTDOWN ALERT: Glitches

Even if you get your overclocked machine to enter Windows, you may still experience glitches. These can include graphics sputtering, mouse trails, intermittent system freezes, system crashes, bizarre error messages, and incorrect calculations. In fact, incorrect calculations may be the most insidious problem: Your system appears to run fine, but how are you to know if your application is hiccuping on math behind the scenes?

If you experience problems, you should reset your processor to its original speed. As columnist Tom Halfhill says, "Reliability is more important than a 10 percent performance gain. I'd add more memory or buy a better graphics card. Overclocking is number 20 on my list."

STEP 1 Before we start our overclocking journey, we need to identify our Pentium II. There are two different models of this processor. The older version—made during the days when the P-II was codenamed Klamath—uses non-ECC L2-cache and a 0.35-micron fab process. The newer version—code-named Deschutes—uses ECC L2 cache and a 0.25-micron process. The CPU we used for testing was the older Klamath version. We determined this by looking at the model number found on the top of the CPU (figure 1). Code number SL28L designates an older 266MHz CPU. To determine the exact specs of any P-II, go to **developer.intel.com/ design/pentiumII/qit** for a complete list of model numbers. Intel's older 266MHz Pentium II runs under the 66MHz system-bus regime. So, with a 66MHz x 4.0 setting, we proceeded to test away.

FIGURE 1

STEP 2 Motherboards from Soyotek (a.k.a. M-Tech) also use a soft BIOS, allowing for jerperless adjustments of CPU clock speeds. While you can adjust system-bus speeds and multipliers, you can't monkey around with voltage; this is taken care of automatically. Happily frolicking across the Soyotek BIOS, we took the P-II 266's standard 66MHz bus to 100MHz. More precisely, we defined a 100MHz x 3.0 setting to achieve 300MHz. Alas—no dice. The system automatically dumped back down to a 200MHz.

STEP 3 Going back into the BIOS, we started fiddling with other system-bus speeds in tandem with a 4.0 multiplier. We didn't even consider raising the multiplier setting past the CPU's default 4.0; we've heard too many tales of late-model P-IIs being afflicted with a lock that denies raising the multiplier setting past its default (lowering the multiplier, as we did in Step 2, can be a different story altogether, however). Regardless, other system bus-settings—68MHz x 4.0, 75MHz x 4.0, and 83MHz x 4.0—refused to dish out 274MHz, 300MHz, and 333MHz respectively.

STEP 4 Unfortunately, the Soyotech motherboard foiled our overclocking efforts at every turn. So, we turned to a Tyan Tsunami AT motherboard, and were met with success! With an 83MHz x 4.0 setting, the Tyan board booted into Windows and ran reasonably fine under a 333MHz regime. We ran a few benchmarks and called it a day.

Analysis:

Not every motherboard is overclockable. New motherboards and BIOS revs make all the difference in the world with these older Pentium IIs. We had the best luck with the Tyan motherboard and its AMI BIOS, which employs a point-and-click GUI interface. It allowed us to set the system-bus speed to 83MHz, but not to 100MHz.

Unfortunately, AWARD BIOS-based boards, such as the Soyotech, refused to go past 266MHz. Changing the soft jumper multiplier resulted in the BIOS announcing setup errors, and a warning that the CPU was indeed locked down at a 4.0 multiplier. That's not to say all AWARD BIOS-based boards are bad for overclocking this specific CPU. Results vary, so choose your motherboard carefully. A great place to check for success stories is on Usenet newsgroups.

Benchmarks:

SYSTEM CONFIGURATION 266MHz Pentium II, Tyan Tsunami AT motherboard (440BX), 64MB PC100 SDRAM, Western Digital hard drive, Sony DVD-ROM drive, Diamond Fire GL 1000 Pro, Diamond Monster 3D II (Voodoo2 with 8MB of video memory)
* Failure could be due to hardware incompatibilities as well as system instability caused by overclocking.

Copyrighted material

AMD Athlon 650MHz

Mission:

The latest golden child of the overclocking world could have been the original Slot A Athlon. While it is multiplier locked, it's the only x86 processor whose protection can be easily bypassed.

When we began our overclocking journey with the trusty Athlon, we had to make a difficult decision. Do we do this the hard way by bumping up bus speeds, or do we take the easy road out and just crank the multiplier up with a Goldfinger device? We grabbed a Goldfinger and got cranking. For those not in the know, the Goldfinger is a nifty little card that attaches to the top of the Athlon and allows the multiplier setting on the processor to be changed.

STEP 1 We attached the Goldfinger to the processor. Of course, to attach the Goldfinger to the CPU, you have to remove the back from the Athlon's enclosure (see figure 1). This is the scariest part of the procedure, but it's fairly easily done by using a small, flat screwdriver to pry the edges apart. Start at the bottom end of the CPU and slowly move toward the top, and you should be just fine.

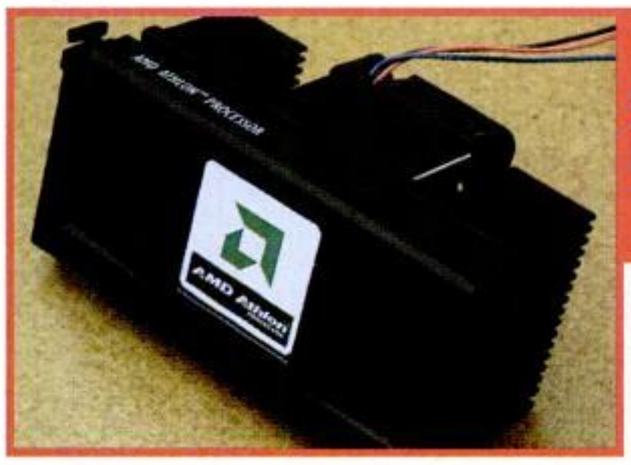


FIGURE 1

STEP 2 Because each Goldfinger varies, be sure to follow the instructions on your card. As a general rule, you'll have to set jumpers or switches for the voltage and multiplier you've chosen (see figure 2). Multiplier and voltage? Which ones will you choose? We generally advocate moving up one bin at a time. For our 650MHz Athlon, we first tested it at 700MHz (7.0x100MHz). Unfortunately, the original Athlon isn't as good an overclocker as older Celerons, or even the new Thunderbird; we were only able to get *bootMark* to run. Either the Athlon's off-die cache wasn't up to the task, or our CPU was an early rev—one of the first 650MHz chips off the line.

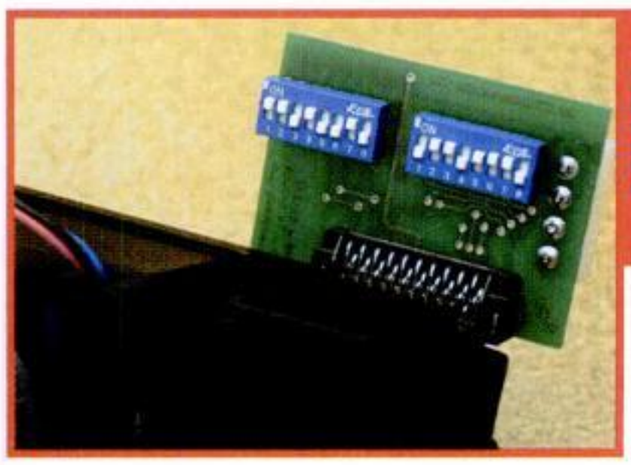


FIGURE 2

Analysis:

Why should the rev of a chip matter? Because the only difference between an Athlon 600 and an Athlon 800 is that the 800 is capable of running at 800MHz. Overclockers get their groove on when the 800's chip yields are so high that AMD sells the 800MHz as a slower processor, keeping demand (and thus price) high for the high-end 800MHz model. In our example, the 600MHz Athlon would probably be a great overclocker (unless there were cache issues), but the 800MHz wouldn't be worth fooling with.

What problems could cache introduce? Because original Athlons used separate chips for L2 cache that ran at a fraction of the chips speed, that cache was also being run at a much higher speed when the processor was overclocked. Because of the cost of high-speed cache memory, AMD usually used the cheapest stuff they could get away with, which could easily hold back an otherwise fine overclocker. Owners of newer Thunderbird CPUs with on-die cache will probably have greater success, but because the Thunderbird uses a chip formfactor rather than a slot, Goldfinger devices aren't effective when it comes to changing locked multipliers.

Benchmarks:

SYSTEM CONFIGURATION Soyo SY-K7AIA motherboard, AMD Athlon 650MHz CPU, 128MB PC133 SDRAM, IBM hard drive, HP 8x CD/RW, Radeon 64MB DDR.
* Failure could be due to hardware incompatibilities as well as system instability caused by overclocking.

MELTDOWN ALERT: Voided Warranties

Before you commence a-clockin', be aware that most manufacturers will void the warranty for every part in your machine if they determine your CPU died during jumper hijinks. We took a trip over to **www.sysopt.com**, where they've set up an overclocking survey. Out of 8,540 overclockers, 7,347 respondents said they have never ruined a CPU. 331 people said that overclocking didn't hurt the processor, but damaged something else in their machine, and 862 said they had damaged or completely fried the CPU. The lesson: Go one bin up and test for stability! Also be sure you have the proper voltage setting for your new CPU speed, because most instant death scenarios result from bad voltage. Consult your mobo manual.

Copyrighted material

DESKTOP THEATER SPEAKERS

Elevate Your PC to Home Theater Status

[DeskTop Theater™ 5.1 DTT3500 Digital]

Bring Dolby® Digital 5.1 home theater sound from your entertainment center to your PC with the DeskTop Theater™ 5.1 DTT3500 Digital speaker system. Boasting a Dolby® Digital Decoder Amplifier, the DeskTop Theater™ 5.1 DTT3500 Digital speakers deliver quality, power, and elegance to any environment. It comes complete with all the cables you'll need to connect a Sound Blaster® Live!™ Platinum 5.1 sound card on the PC, Sony® PlayStation 2™ console, portable audio devices and more.

Don't compromise sound quality for location. Dignify your PC with the DeskTop Theater™ 5.1 DTT3500 Digital speaker solution.

EAX™ DOLBY DIGITAL

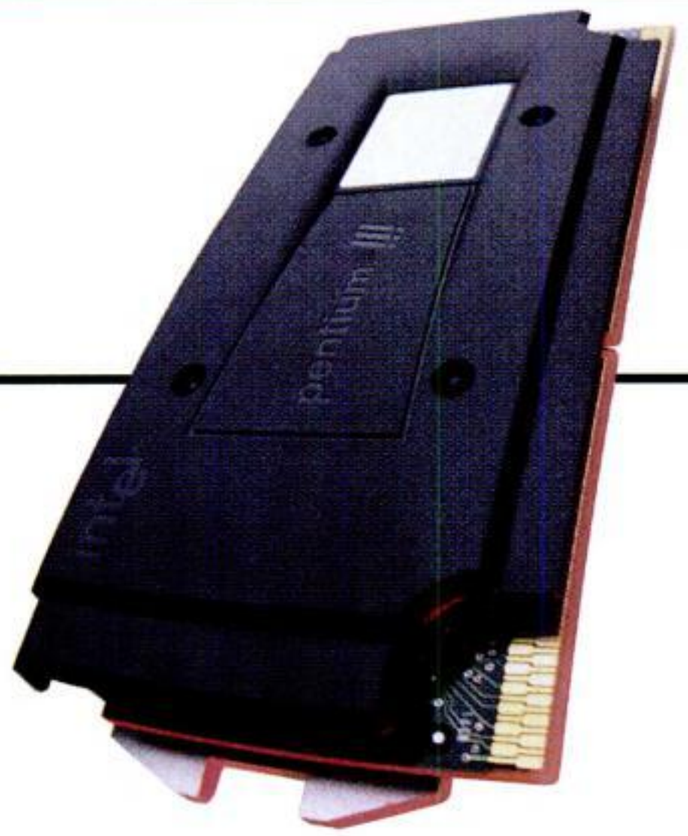
Visit **www.creative.com** for more information.

©2000 Creative Technology Ltd. All brand or product names listed are trademarks or registered trademarks and are property of their respective holders. If you're not on the net, give us a call at 800.998.1000 for more information.

CREATIVE®
PERSONAL DIGITAL ENTERTAINMENT
Starts Here.

Copyrighted material

Pentium III 933MHz



Mission:

Our next overclocking victim is the 933MHz Pentium III. The 933 is based on a 0.18 micron process, and has 256KB of on-die L2 cache tucked into a tidy FC-PGA formfactor.

STEP 1 Because the P3-933 has a locked multiplier, we're limited to overclocking the frontside bus exclusively. To facilitate this, we chose the Soyo SY-6VCA motherboard, which has a wide selection of bus speeds to choose from in its SoftMenu BIOS. In order to crank the 933 up to our target of 1GHz, we need to be able to run the CPU at around 143MHz, which will result in a PCI bus speed of 36MHz. Since most PCI devices shouldn't have problems functioning at this speed, the limiting factor will be the CPU's ability to run at 1GHz.

STEP 2 The first stop on our journey to 1GHz is at the 135MHz bus speed. Unfortunately, though our test system was able to boot at 945MHz, not even the venerable *bootMark* would run at this speed. It's time to remove the puny little heatsink that's planted on the Pentium III and replace it with something a little beefier.

Removing the heatsink/fan combo from a Pentium III isn't an easy thing to do, and can do permanent damage to your CPU if you aren't careful. In addition, it will render your current heatsink useless, so don't try this unless you already have a replacement (that fits in your case) lined up. First, grab a set of metal snips and cut the four supports that go through to the other side of the cartridge. Pull both sides away from the chip (see figure 1). It's easier to do this when the CPU is still hot, because the thermal paste acts like glue when it has cooled down. Next, you'll need to add a beefy cooler—preferably one with more efficient cooling fins and fans, such as the Alpha heatsink shown in figure 2. Fan/heatsink combos employ many different retention mechanisms, so read the manufacturers instructions to avoid goof-ups. Don't forget to add a dab of thermal compound to facilitate heat flow from the CPU to the heatsink.

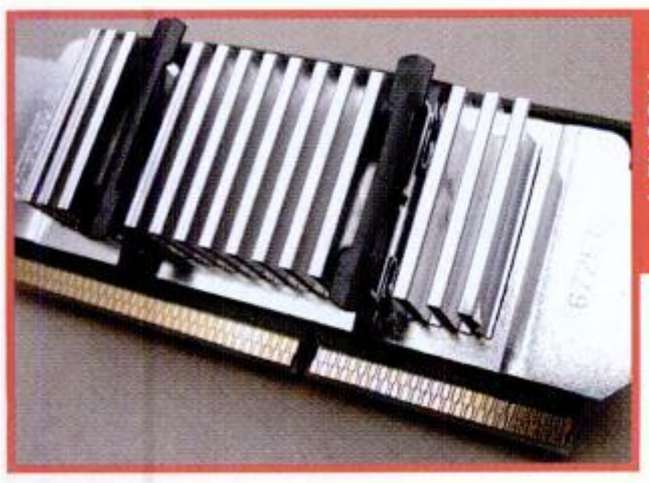


FIGURE 1

FIGURE 2

STEP 3 Unfortunately, our test system still wouldn't run at 950MHz, even with the addition of the monstrous Alpha heatsink/fan combo. An overclocker unsatisfied with these results might add extreme cooling measures, such as a thermo-electric cooler (TEC), also known as a Peltier, or a heat pipe. TECs basically suck heat from one side of a metal plate and blast it out the other. The practical upshot is that when enough current is applied, the cold side of the plate can reach around –40 degrees F. Unfortunately, the metal isn't very thick, which means that the heat removed from the cold side of the plate has to be dumped into the case, which has to be dissipated through more fans.

Analysis:

Overclocking only pays off big when Intel clocks faster processors at lower speeds to keep up demand (and price) for those faster processors. Unfortunately, there aren't enough P3s that will do 1GHz+ to go around, so you shouldn't expect to see many 1GHz procs in 933MHz clothing for the time being.

Benchmarks:

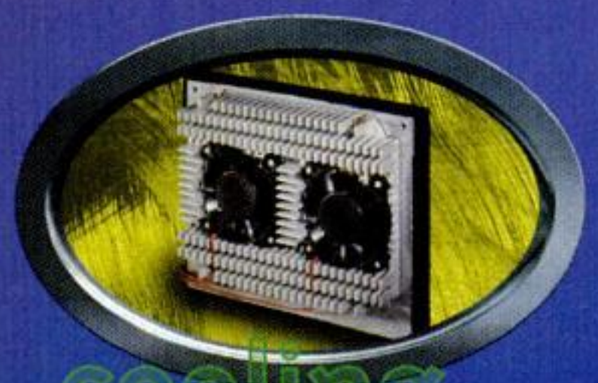
		933MHz (133MHz x 7.0)	950MHz (135MHz x 7.0)
CPU/MOTHERBOARD	bootMark	457	failed*
WIN98 APS	SYSmark 2000 official score	179	failed*
DIRECT3D	3DMark 2000 fps	63.9	failed*
OPENLGL	Quake III Arena fps	67.2	failed*

SYSTEM CONFIGURATION Soyo SY-6VCA motherboard, Intel Pentium III 933MHz, 128MB PC133 SDRAM, IBM hard drive, HP 8x CD/RW, Radeon 64MB DDR.
* Failure could be due to hardware incompatibilities as well as system instability caused by overclocking.

MELTDOWN ALERT: Too Much Heat

All integrated circuits, be they CPUs or 3D accelerators, generate greater amounts of heat the higher you clock them. If you run them beyond their spec'd frequency, you run the risk of literally fusing your circuit paths or slowly burning them out over time. Quick death means an instantaneous, irreversible system crash. Slow death means increasingly frequent lock-ups and glitches. Excessive heat can even damage other system parts. The only solution is to apply one of the cooling strategies on the next page. More-efficient fab processes help circuits run cooler, but don't feel invincible just because your CPU is fabbed at 0.25-micron. At 300MHz, that fab has room to grow. At 450MHz, it's already pushing its limits and definitely needs cooling help.

Copyrighted material



cooling devices

enclosures

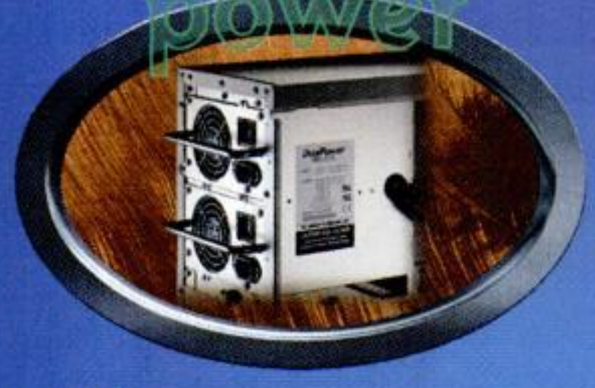
base systems

PC POWER & COOLING, INC.®

heat alarm & accessories

power supplies

redundant power



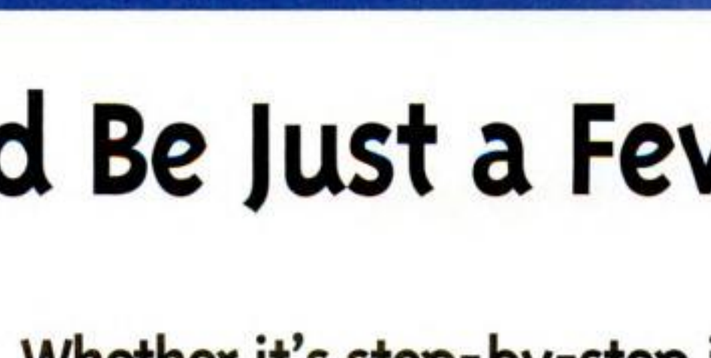
$25,000 Could Be Just a Few Clicks Away!

15th Anniversary $25,000 Sweepstakes

To celebrate our 15th anniversary, we're giving away $26,000 cash, $8,000 in PC Power and Cooling products, and a wild trip to Vegas! (See list of prizes below.) It's simple — just order online, and you're automatically entered in the sweepstakes! Winners will be posted November 15, 2000. See our website for official rules and details.

Grand Prize	• $25,000 Cash and Trip to Las Vegas • Deluxe Chrome Tower Case with a Turbo-Cool 425 ATX
First Prize	• $1,000 Cash • Deluxe Chrome Tower Case with a Turbo-Cool 425 ATX
Second Prize	• $500 in PC Power & Cooling Products (5 winners)
Third Prize	• $200 in PC Power & Cooling Products (20 winners)

Whether it's step-by-step instructions on how to build your own system, an interactive guide to power supply selection, 360° views of our pro enclosures, or a chance to win $25,000, you'll find it at pcpowercooling.com


PC POWER & COOLING, INC.

What's New

eMachine 145W power supply	The solution to a huge problem!
Dell 300W power supply	The power a loaded Dell deserves!
Standard 250 ATX power supply	Same price as the 235 it replaces!
Silencer 400 ATX power supply	Ultra-quiet *and* high-performance!
Turbo-Cool 425 ATX power supply	500W peak power! 1% regulation!
Bay-Cool III drive cooler	Cool, filtered air for 1-3 drives!
CPU-Cool Z1 "S" series coolers	Low-noise *and* ultra-reliable!
ATX power supply tester	The first universal, low-cost tester!

TEN GREAT REASONS TO SELECT THE INDUSTRY'S BEST, THE TURBO-COOL® 425 ATX AND TURBO-COOL® 600 AT/ATX.

1. 50% TO 100% MORE POWER
2. BUILT-IN LINE CONDITIONING
3. AUTO-SELECT INPUT
4. ULTRA-CLEAN DC OUTPUT
5. INDEPENDENT REGULATION
6. OVP, OCP, OTP, SC PROTECTION
7. HIGH-CAPACITY COOLING FAN
8. UL/CE/FCC APPROVALS
9. 5-YEAR WARRANTY
10. GREAT VALUE

New Products!

Tech Info!

Celebrating Our 15th Anniversary!

www.pcpowercooling.com

(800) 722-6555 Fax: (760) 931-6988

Weekly Specials!

Online Ordering!

Copyrighted material

Without some type of device drawing heat away from its circuitry, an integrated circuit will cook in its own juices. Here are some common ways to keep your silicon chillin'.

PASSIVE COOLING: The simplest way to cool any processor is to saddle it with a massive heatsink. The heatsink acts as a dissipater, drawing heat away from the processor and distributing the frisky electrons into the surrounding environment. The old adage "bigger is better" holds true for heatsinks. The greater the surface area of the heatsink, the better the heat dissipation. Increasing surface area can also be accomplished via finer, more numerous heatsink fins.

ACTIVE COOLING: This strategy throws a fan onto the heatsink itself. The fan promotes air circulation among the heatsink fins, which in turn promotes a cooler environment. Most modern CPUs employ active cooling, although with the advent of the ATX motherboard formfactor—which positions the CPU right next to the ATX power-supply fan—some vendors are reverting to simply slapping a massive, extruded heatsink on their CPUs.

PELTIER COOLING: Some heatsinks incorporate a thermoelectric cooler, or Peltier element, into their design. When this thermoelectric cooler (TEC) is wired to a DC power source, the electric current causes heat to move from one side of the TEC to the other. This creates a hot side and a cold side—and the cold side of the element sits right on top of the CPU (the hot side straddles the heatsink). Some caveats: Water condensation has always been a concern with Peltier cooling, because the cold side does get icy to the touch. And, while the cold side of the Peltier element chills the CPU, the hot side creates more heat for the rest of your components. Finally, Peltier coolers do draw significant power, so be sure your power supply can handle the drain.

SOFTWARE: Different utilities that claim to help overclockers cool their CPUs have recently popped up across the Internet. *Rain*, *CPUIdle*, and *Waterfall Pro* are three such programs. They work by shutting down certain processing functions while the processor is running, effectively putting parts of the CPU into an idle state. According to the *CPUIdle* web site, "*CPUIdle* lowers the CPU temperature by disabling it when not needed. This prolongs the CPU life (a decrease by 10°C doubles the life span) and cuts power consumption. Unlike normal power management, *CPUIdle* is active all the time and works even when you're actively using your computer!"

Maximum PC columnist and CPU magnus Tom Halfhill isn't buying the hype. He says, "Frankly, the whole idea seems pointless for a desktop PC, which should have plenty of room inside the box and a strong enough power supply to keep the CPU cool with fans and vents. If the CPU is properly cooled with airflow, it doesn't need a trick program. The program might have some use in a laptop, but the CPU, OS, and BIOS should already be doing some of those things. It's even more pointless to overclock a CPU and then cap its performance at less than 100 percent to keep it from overheating. That's like souping up a car engine and then installing a governor to keep you from speeding. Why bother?"

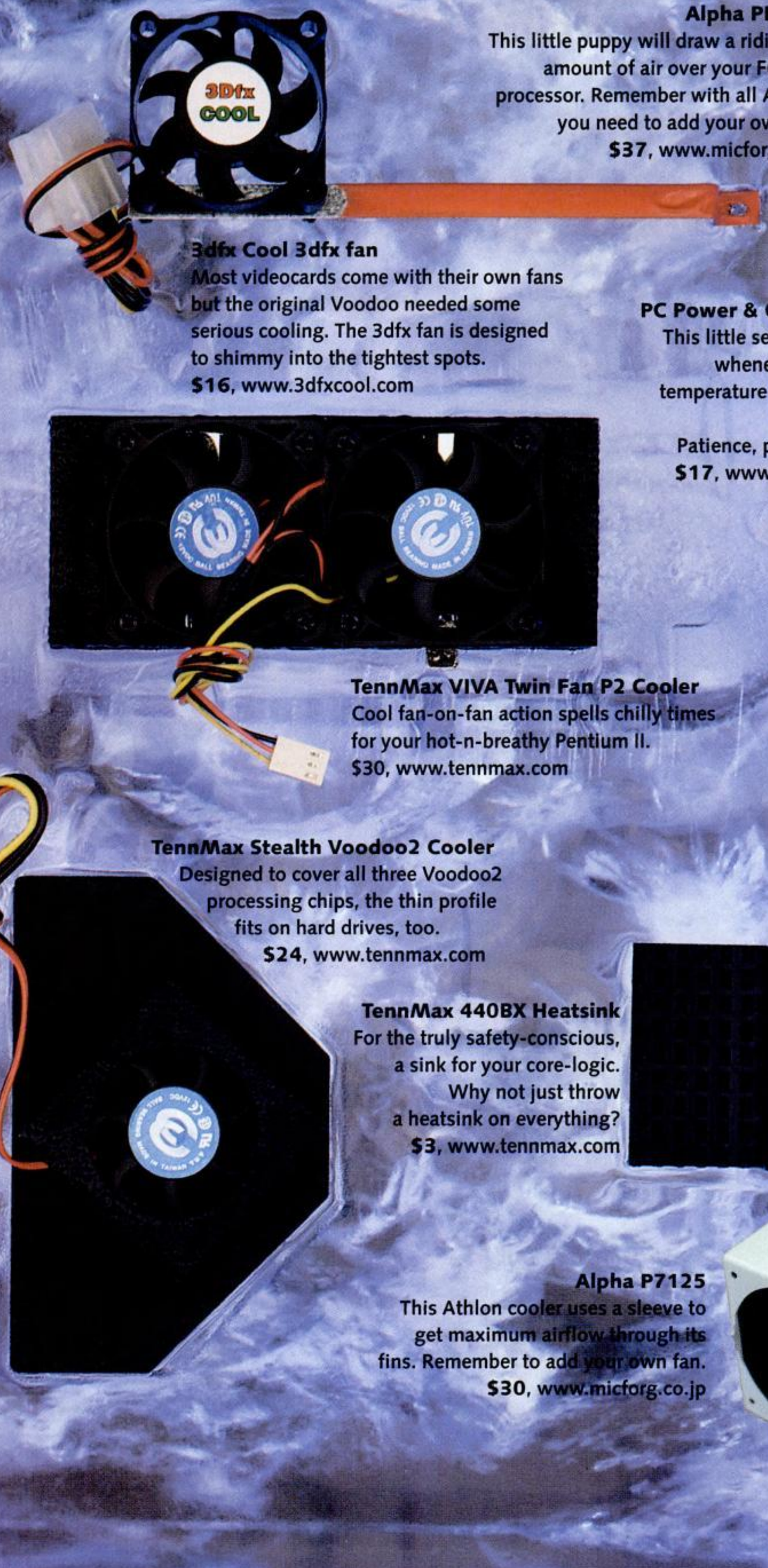
From fans to heatsinks to combo units to alarms, cooling devices are just plain chill. Here's the tip of the iceberg—hundreds more units can be found online.

PC Power & Cooling Socket 8 Dual CPU
Cool straight outta the Terrordome, this mad-coolin' brute's post-apocalyptic design will scare heat off your Pentium Pro.
$32, www.pcpowercooling.com

Vantec PII-SL5015 Celeron Heatsink/Fan
The four rivets fit directly onto the exposed Celeron Slot 1 cartridge; perfect for the most overclockable of CPUs.
$13, www.vantecusa.com

Micron Socket 7 "Blue Boy"
This fancy sink came attached to a stock P233 in an old Micron machine. It was so pretty, we ripped it off the proc and put it on ice. The "parking garage" design eschews fins for multileveled wafers.

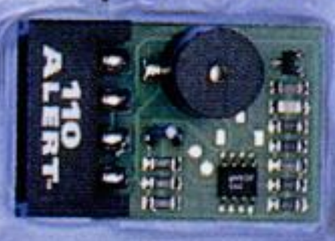
Copyrighted material



Alpha PEP66T
This little puppy will draw a ridiculous amount of air over your FC-PGA processor. Remember with all Alpha's you need to add your own fan.
$37, www.micforg.co.jp

3dfx Cool 3dfx fan
Most videocards come with their own fans but the original Voodoo needed some serious cooling. The 3dfx fan is designed to shimmy into the tightest spots.
$16, www.3dfxcool.com

PC Power & Cooling 110 Alert Overtemperature Fan
This little sentry lets out a whistle whenever your internal case temperature enters the alarm zone beyond 100 degrees. Patience, patience, Piccolo Pete!
$17, www.pcpowercooling.com

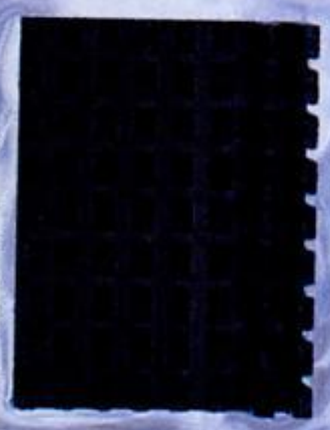


TennMax VIVA Twin Fan P2 Cooler
Cool fan-on-fan action spells chilly times for your hot-n-breathy Pentium II.
$30, www.tennmax.com

PC Power & Cooling CPU-Cool Z1
This ugly mutha is spec'd to cool Socket 7 procs running from 233MHz to 350MHz. **$21**, www.pcpowercooling.com

TennMax Stealth Voodoo2 Cooler
Designed to cover all three Voodoo2 processing chips, the thin profile fits on hard drives, too.
$24, www.tennmax.com

TennMax 440BX Heatsink
For the truly safety-conscious, a sink for your core-logic. Why not just throw a heatsink on everything?
$3, www.tennmax.com



Alpha P7125
This Athlon cooler uses a sleeve to get maximum airflow through its fins. Remember to add your own fan.
$30, www.micforg.co.jp

Copyrighted material

A few reasons
millions of AMD Athlon systems
have been sold worldwide.

CPU of the Year
Maximum PC, December 1999

Product of the Year
PC World, June 2000

Best Overall Product of the Year
PC Magazine (UK), December 1999

Best Product of 1999
(Hardware), Windows NT Systems, January 2000

Analyst's Choice Award - Best PC Processor
Microprocessor Report, January 2000

Technical Excellence - Best Component
(Hardware Category), PC Magazine, November 1999

Wired for 3D Editors' Choice
3D Magazine, January 2000

AMD
Athlon PROCESSOR

Go to www.amd.com/awards for a complete list of worldwide awards.

© 2000 Advanced Micro Devices, Inc. AMD, the AMD logo, AMD Athlon, and combinations thereof are trademarks of Advanced Micro Devices, Inc.
Other company, brand and product names may be trademarks or registered trademarks of their respective holders.

Copyrighted material

Christen your

Nothing breaks our hearts like discovering that a brand-new, 800MHz machine has been crippled by its manufacturer. Whether voluntarily or by evil edict, the men on the assembly line often fill hard drives with resource-hogging applications that you'll never use, turn off switches that would give you major speed increases, and leave out software support for the technology you paid for. Hell, that's just the short list. The basic Windows configuration is just plain annoying.

But you don't have to stand for it. Whether you've just removed a brand new system from its packaging or have been using the same old 266MHz Pentium II for years, follow the next 30 tips to maximize your machine's potential, prepare it for future expansion, and make it easier to use. Our pointers represent the best of *Maximum PC*'s institutional knowledge—and we're the type of guys who like to roll up our shirt sleeves and tweak systems down to the motherboard, BIOS, and Registry level. We close out the article with some killer tips from readers, a bottomless resource of knowledge and ingenuity.

30 TIPS TO BLAST PERFORMANCE OUT OF THE BOX

TIP 1 A clean place to swap

Windows works best when its swap file lives on a fast, uncluttered hard drive. If you want the best performance out of your dual-drive PC, determine which drive is the speediest and free up enough space on that drive to fit your swap file. You can determine how much space your swap file currently takes up by looking at the size of the WIN386.SWP file in the Windows directory. To relocate the swap file, open up the Virtual Memory settings in the Performance section of your System Properties and specify the new hard drive. If you have one hard drive, get a good hard drive partitioning utility, such as *PartitionMagic 5.0*, and put your swap file in an empty partition. If you can dedicate a partition solely to your swap file, you don't have to worry about it becoming fragmented through reading, writing, and erasing other files.

TIP 2 Knowing is half the battle

If you're running Windows 98 or Windows ME, check out the new tools available in the souped-up Microsoft System Information utility. Available from a pull-down menu within System Info, these tools keep your system running smoothly by putting all the important Windows configuration information under your thumb. The most important tools found here are the System Configuration Utility, which provides intimate access to the innards of your OS, and the System File Checker, which scans and catalogs the version information of all your important DLLs, INFs, and VxDs. If it detects a new file version, System File Checker will prompt you to update the catalog or restore the old version from the install CD.

TIP 3 Nixing the Task Scheduler

If you download and install the Microsoft Critical Update Notification, it embeds the Task Manager so that it comes up every time you reboot, whether you turn it off or not. You can make it stop by uninstalling the Critical Update Notification utility using the Add/Remove Programs Control Panel. Unfortunately, WinME has integrated Critical Update into its innards, so you can't ever remove it from your shiny new OS.

TIP 4 Store important files in a cool, dry place

Create a directory on an empty hard drive partition for backups of all your important data. Irreplaceable documents, pictures from your new digital camera, browser bookmarks, and saved games are too valuable to lose. Mailboxes are particularly important, and several e-mail apps now include auto-archiving features that automatically back mailboxes up to a safe and secure location.

TIP 5 Uninstall what you don't understand

Hard drive space is precious, so you should be familiar with all the software installed on your system. If you don't recognize it, investigate it. Is it useless "edutainment" software installed by the system manufacturer? Does it have anything to do with the essential operation of your PC? If it doesn't pass muster, use the Add/Remove Programs wizard to yank it from your directories and Registry. Start by uninstalling the contents of your Online Services folder, which consumes about 40MB of disk space care of setup software from various online services.

TIP 6 Use ACDSee for image viewing

Just over 1MB in size, *ACDSee* is the best image viewer we've ever used. Its thumbnail browser lets you view images without actually opening them, and is customizable ad infinitum. The utility requires very little memory, supports most image formats, and includes advanced features such as read-ahead cache, slideshow, and autosizing. But the best part is *ACDSee's* speed—it's much faster than *Photoshop*, *Image Viewer*, or *Paint*. Get *ACDSee* from **www.acdsystems.com**.

TIP 7 Evict System Hobos

HOW IT HELPS

You'd be surprised by how many active programs buzz around your system, hiding in the background, eating up precious CPU cycles and memory without permission. Some come pre-installed in your StartUp directory, and automatically load whenever you boot your computer. Others hitch rides on top of applications you install. For example, the Microsoft Fast Find utility automatically installs when you install Office. It then loads during startup, and sits in the background in order to index all your documents when your PC isn't "busy." Find Fast considerably slows your PC down every time it updates its file index, so it's a good idea to kill it. In fact, a lot of other subversive background applets should also get the axe.

HOW TO DO IT

Hit Ctrl/Alt/Del to bring up the Close Program dialogue box, which lists everything currently running on your PC. Do you recognize every program? The applications you voluntarily loaded are easy to spot, but meaningless monikers such as "Osa" and "Vshwin32" make it a little more

Copyrighted material

System

TIP 7 — Recognize any of these bums? You can find most of them hiding in your Startup menu and Registry.

difficult to identify offending programs.

Go to Taskbar Properties and hit the Advanced button under the Start Menu Programs tab. Browse to the PROGRAMS\ STARTUP directory. Here you'll find the shortcuts to apps that load unbeknownst to you. Right-click a possible offender and hit Properties. The Target field under the Shortcut tab will list the name of the program as it appears under the Close Program dialog box (as well as the location of the program for subsequent eradication). Now decide whether the program deserves the bum's rush out of your StartUp menu, or even off your hard drive entirely.

If you have system hobos that can't be located in the StartUp Menu, you should find them loitering in your Registry. Fire up REGEDIT, and open the **Hkey_Local_Machine\Software\Microsoft\Windows\CurrentVersion\Run** (or Run Services) folder to see what Windows is loading behind your back. Now delete the keys that load offending apps. Before editing your Registry, always remember to back it up via the Export Registry File menu option (choose "all" under Export Range).

If you don't have the stomach to dig through your Registry, you can use the System Configuration Utility described in Tip 2 to select what you want to load automatically when Windows boots. Just launch Open System Config from the Tools menu of the System Info utility, then go the Startup tab and uncheck the items you want to keep from loading.

TIP 8 Remove Memory-Hogging TSRs

HOW IT HELPS

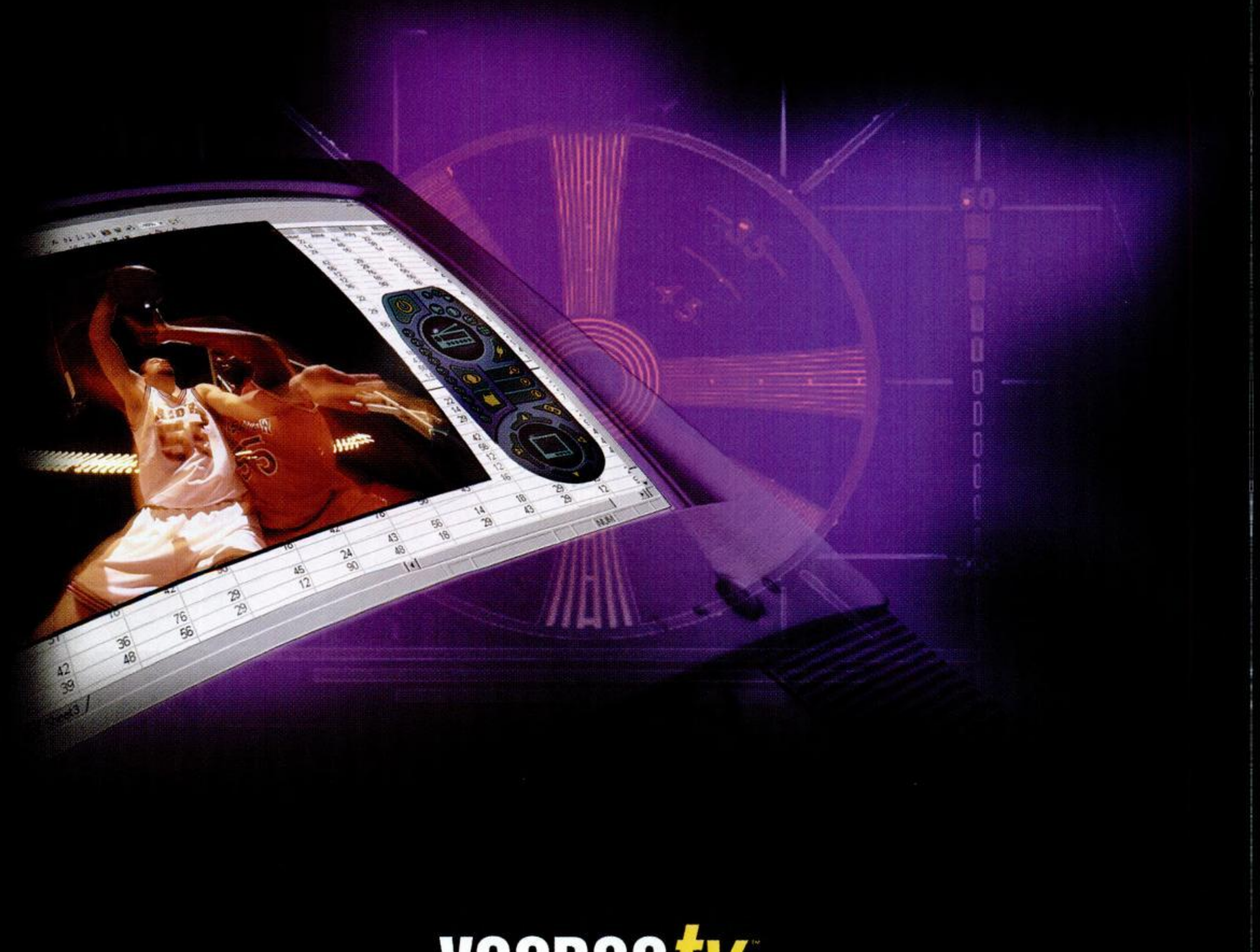
AUTOEXEC.BAT and CONFIG.SYS, holdovers from the old DOS days, are batch files that run at startup. There's nothing inherently evil about this, but unfortunately, these files launch Terminate and Stay Resident apps (TSRs), which load into system memory until summoned. Chances are that these buggers shouldn't be loading until you need them, so wipe 'em out of your startup regimen.

HOW TO DO IT

Do a file search for AUTOEXEC.BAT and CONFIG.SYS. Open each with *Notepad*. Look for items you can nix, such as "real-mode" DOS drivers and anti-virus scanners. If you're skittish about wiping out a line entirely, simply add REM to the front of the line in order to disable the instruction. Experiment to get the best results, and delete your REM instructions if you've disabled an important app. In

Copyrighted material

From the people who brought you Voodoo™ Graphics comes
a new way to be completely unproductive



VOODOO*tv*™

TURN YOUR PC INTO A TV

3dfx
www.3dfx.com

Copyrighted material

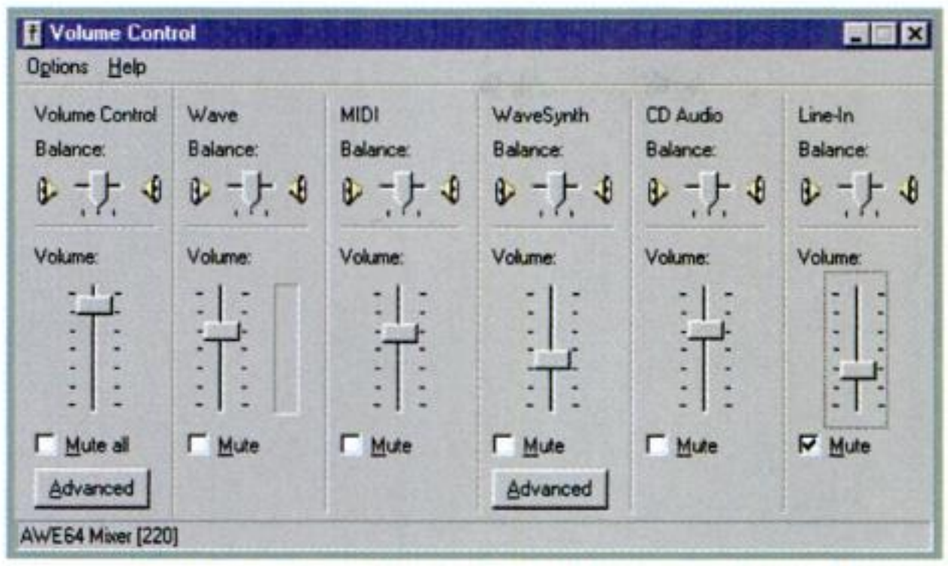
A dirty AUTOEXEC.BAT might look like this:

```
C:\WINDOWS\MOUSE.COM
C:\PROGRA~1\NETWOR~1\MCAFEE~1\SCAN.EXE C:\
C:\WINDOWS\AZTPNP.EXE /A:ON /IDE:OFF
SET BLASTER=A220 I5 D1 T4
```

It should look like this:

```
REM C:\WINDOWS\MOUSE.COM
REM C:\PROGRA~1\NETWOR~1\MCAFEE~1\SCAN.EXE C:\
C:\WINDOWS\AZTPNP.EXE /A:ON /IDE:OFF
SET BLASTER=A220 I5 D1 T4
```

general, Windows 95/98 doesn't need much in either file to run properly, and you can definitely use all the memory resources possible.



TIP 9 — Don't mess with my sliders... I got 'em tuned just right.

TIP 11 — Win98 and ME come with their own FAT conversion utility.

TIP 9 Optimize Volume Controls

HOW IT HELPS

If a soundcard's mixer controls aren't set correctly, high volume settings will hiss and distort, while low settings will give you anemic acoustics.

HOW TO DO IT

Look in the lower-right corner of your Windows Taskbar. If your soundcard is installed properly, you should see a small speaker icon. Double click on it to bring up your Volume Control mixer. As you can see, there's a slider for every channel—MIDI, WaveSynth, CD Audio, etc. Pull all sliders to three-quarter intensity. Now, fire up your favorite audio CD and turn your external speaker volume all the way up. If you hear crackling and distortion, turn the CD audio slider down until the noise disappears. Now, fire up a WAV file. If you hear distortion, lower the Wave volume slider until the offending sound disappears. Repeat this process with other sound devices as needed. If you find that you need to turn a bunch of sliders down, your master volume control may be too high. Pull back on the master control until your sound is clear. Finally, be sure each slider's Mute box is unchecked.

TIP 10 Overclock Your CPU

HOW IT HELPS

By flipping a few motherboard jumpers or adjusting a simple BIOS setting, you can actually increase the clock speed of your CPU, effectively turning a 600MHz Pentium III into an 800MHz, for example. The process is called overclocking. It generates a lot of extra heat and can result in fried CPUs, so don't even think about trying it unless you have a strong stomach. Overclocking is also reviled by much of the computing industry, and it voids most warranties. Still, thousands upon thousands of people have taken the overclocking leap of faith with no ill effects, so the practice must have some merit, right?

HOW TO DO IT

A CPU's speed is determined by the speed of the system bus multiplied by an arbitrary number (aptly called a multiplier). For example, a 600MHz Pentium III is the product of a 100MHz system bus and a 6.0 multiplier. To get to 800MHz, you'll need to increase the system bus to 133MHz (check out our "Turbocharge" feature on page 14 for more info). System bus and multiplier settings have traditionally been set through physical jumper switches scattered across your motherboard. In more modern systems, however, the settings are integrated into the system BIOS, which you can enter by hitting either DEL, F1, or F2 during startup. Consult your motherboard manual for the bus settings location. If you don't have a manual, go to the motherboard manufacturer's web site and look for online documentation.

Of course, during any kind of overclocking, you always want to increase speed by a single increment (known in the industry as a bin) and test for system stability. Severe instability comes in the form of boot failure. Mild instability comes in the form of intermittent system lock-ups and graphical glitches. If you suffer any kind of instability, try a different overclocking strategy, such as tweaking your multiplier instead of your bus speed, or return to your original settings and give upon overclocking. Remember: Overclocking can destroy your CPU and voids its warranty. And before you try it, always consider cooling strategies.

CELERON 266 WITH 4.0 MULTIPLIER		CELERON 300 WITH 4.5 MULTIPLIER	
Bus Speed Tweak	Resulting Speed	Bus Speed Tweak	Resulting Speed
66MHz	264MHz	66MHz	297MHz
75MHz	300MHz	75MHz	337MHz
83MHz	332MHz	83MHz	373MHz
100MHz	400MHz	100MHz	450MHz
103MHz	412MHz	103MHz	463MHz
112MHz	448MHz	112MHz	504MHz
124MHz	496MHz	124MHz	558MHz

TIP 10 — The Celeron overclocking schedule illustrates just how high you can go with the bus adjustments on today's motherboards. Just expect major cooling and instability problems with the fastest bus settings. At these speeds, CPUs, core-logic chipsets, RAM, and PCI cards have difficulty cooperating with each other.

TIP 11 Get Fatter

HOW IT HELPS

The FAT16 file system is an atavistic throwback to the days when hard drive platters were the size of vinyl records and capacities maxed out at 20MB. OK, maybe FAT16 didn't go back that far, but its sloppy, cluster-wasting ways and 2GB partition limit definitely make you wonder whether it was designed in the dark ages. It just doesn't make any sense on the multi-gig monsters of today.

Initially introduced in OSR2 and popularized in Windows 98, FAT32 makes more efficient use of larger hard drives by using smaller cluster sizes and supporting partitions of up to two terabytes (2048GB). FAT32 actually increases the size of your hard disk through more efficient use of cluster sizes, and is a particularly important part of Win98's improved file and memory management capabilities. If you're system is set to FAT16, beef it up to FAT32.

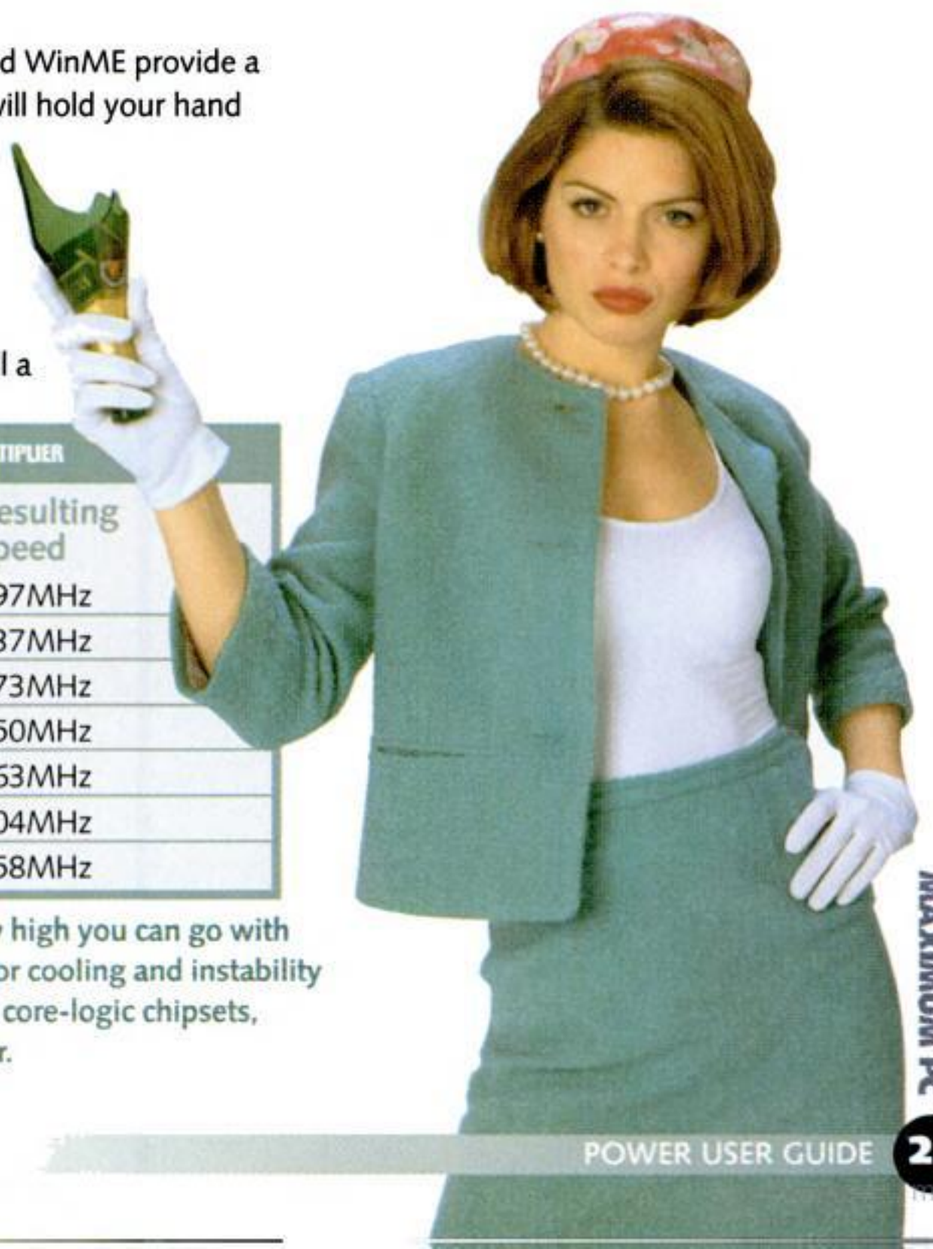
HOW TO DO IT

Luckily, Win98 and WinME provide a safe wizard that will hold your hand as you enter the wonderful world of FAT32. Though the conversion utility works well, it's still a good idea to back up all your important files, since the conversion is a one-way-only process. If you ever decide to uninstall Win98, an old-fashioned FDISK or a third-party utility such as *PartitionMagic 5.0* are the only ways to switch the drive back to FAT16. Let it be known that Windows NT 4 doesn't associate itself with FAT32 drives, but Windows 2000 does.

TIP 12 Toggle on DMA

HOW IT HELPS

Direct Memory Access (DMA) is a memory architecture embedded into your motherboard's core-logic chipset that allows for the transfer of data between system memory and storage drives without stealing precious CPU clock cycles. Without DMA, the system must interrupt the CPU for a minimum of 16 cycles every time it wants to read from or write to a hard drive, CD-ROM drive, or DVD-ROM drive. With DMA enabled, however, the system can perform the same task in just two or four cycles. Most new



Dogfight opponents online in cutthroat multiplay.

Fly 11 tricked-out planes in 24 thrilling missions.

The 1930s ain't what they used to be. America lies in pieces and air power is king. It's a shoot-or-get-shot-down world. You'll dogfight ruthless air pirates. Rescue saucy pinups. Dodge flak from dicey femmes fatales. And mix it up with other aces online. But remember, one thing still holds true—don't get mad, get even.
www.microsoft.com/games/crimsonskies

Big guns. Fast planes. Gorgeous dames.

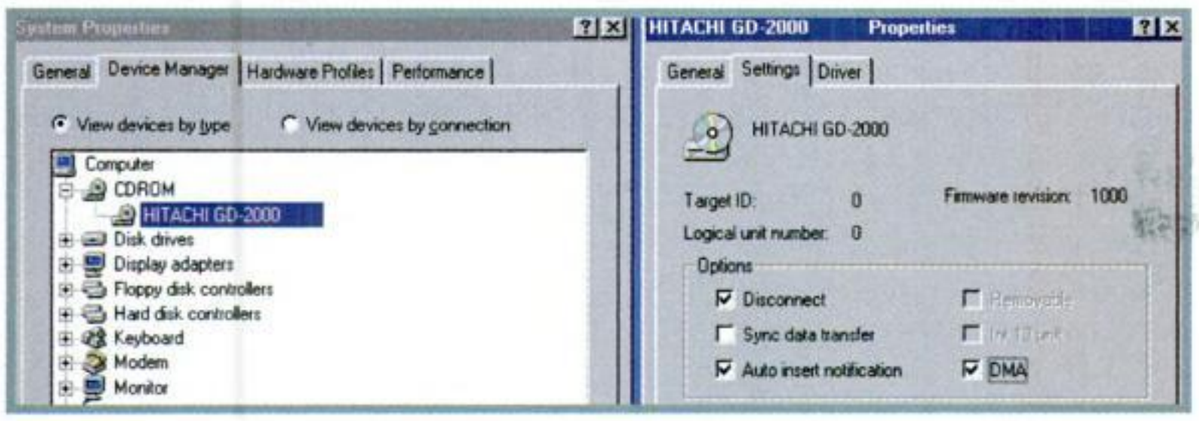
CRIMSON SKIES

Microsoft Zone.com ZIPPER INTERACTIVE

TEEN T CONTENT RATED BY ESRB
Animated Violence
Use of Alcohol

© 2000 Microsoft Corporation. All rights reserved. Microsoft and Crimson Skies are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

Copyrighted material



TIP 12 — It's just a simple little checkbox item, but without DMA enabled, you are losing performance.

drives are DMA-compliant, but idiot system manufacturers fail to enable the technology.

HOW TO DO IT

You can enable DMA by going to your Device Manager under System Properties and double-clicking the icons of each individual storage drive. This brings up the Properties menu for each device. Hit the Settings tab, and if the DMA box is present, be sure it's checked, then restart.

Your BIOS also needs to support DMA and have it enabled. For the right BIOS setting, check your motherboard manual for references to IDE transfer modes. Win98/ME also needs the right bus-mastering drivers, which usually come with a new motherboard or machine. Find Intel's standard bus-mastering drivers at **http://support.intel.com/support.controllers/peripheral/**.

TIP 13 Optimize your display

Begin by going to your Display Properties control panel and setting the optimum resolution for your monitor size. Unless you're doing high-end design work, we recommend 1024x768 for 17-inchers and 1280x1024 for 19- and 21-inchers. Next, maximize your screen real estate by upping the horizontal and vertical size settings in your on-screen control panel. Now, download the DisplayMate demo from **www.displaymate.com** and use the sample screens to adjust brightness, contrast, and geometry.

TIP 14 Burn in your PC

Most system makers put their machines through a series of component tests before sending out their boxes. This is known as "burning in" a system to ensure that all the components work together without conflicts. While low-level component tests are fine and dandy at the factory, nothing beats challenging your new system with real software. So before you begin stuffing your hard drive with apps and personal documents, run a looping *Quake III* or *Unreal Tournament* demo for a 24-hour period (activate all advanced 3D rendering options and set the game to 1024x768 if possible). This test will stress all subsystems and cause a lemon to reveal bad drivers, bad settings, and inadequate component cooling.

TIP 15 Backup CD-ROM drivers

After you've formatted your hard drive or wiped out the Windows directory, nothing's worse than discovering you don't have a boot disk that contains your CD-ROM drivers. If you're still living in the stone ages of Windows 95, you should have a backup disk that'll crank up your CD-ROM drive under DOS. If your drive came without DOS drivers, visit the manufacturer's web site and download the DOS drivers and installation program. From your Windows/Commands directory, you'll also want to copy over the DOS commands Edit, Format, Fdisk, Himem.sys, Mscdex, and Extract, as well as anything else you may need when trapped in the C: world. Windows 98 and ME users have the easiest route to creating a boot disk. Simply go to the Add/Remove Programs Control Panel and select Start Up Disk to create a generic boot disk that'll work with almost any CD-ROM drive.

TIP 16 Tweak MSDOS.SYS

HOW IT HELPS

Windows 95/98 receives startup instructions from MSDOS.SYS, a text file located on the root of your main hard drive, usually C:\. By changing default instructions, you can enable boot options designed for power users and ditch the startup screen they gave you when you enlisted in the Microsoft army.

HOW TO DO IT

In older versions of DOS, MSDOS.SYS was an unreadable system file. In Windows 95/98, however, it's a readable ASCII file that's structured like an initialization (.INI) file, making it easy to edit. Most settings can be toggled with either a zero (0) to disable, or a one (1) to enable. Use

TIP 16 — A large section of MSDOS.SYS contains letters with semicolons in front of them. These letters pad the file, making sure it's larger than 1024 bytes (the semicolons prevent the gibberish letters from being read by the system). The letters are included for certain programs that need to verify the DOS version that's running and can only do so if the MSDOS.SYS file is large enough.

any text editor to make changes, then restart your machine to enable your handiwork. If the instruction you want to change isn't already in your MSDOS.SYS file, simply add the appropriate syntax under the heading marked OPTIONS. Beware of editing the MSDOS.SYS file in ME, as it can have unexpected (and unpleasant) side effects. Here are some of our favorite startup tweaks:

`BootDelay=[x] (default is 2)`
This sets the number of seconds of delay before Win95 starts. A longer delay count gives you more time to press a function key for specific booting options (see BootKeys).

`BootKeys=0 or 1 (default is 1)`
Enables the startup option keys (F4, F5, F6, and F8). Setting this to 0 prevents any startup keys from functioning. F4 will boot your previous version of DOS. F5 will start the system in safe mode. F6 will step through your CONFIG.SYS and AUTOEXEC.BAT commands one by one. F8 will bring up the boot Menu.

`BootGUI=0 or 1 (default is 1)`
Enables automatic graphical startup into Win95. The 0 setting boots to a DOS prompt (you can then type "WIN" to start Win95).

`Autoscan=0 or 1 (default is 1)`
Setting this to 0 turns off the auto-scandisk that kicks in on bootup when Windows was improperly shut down.

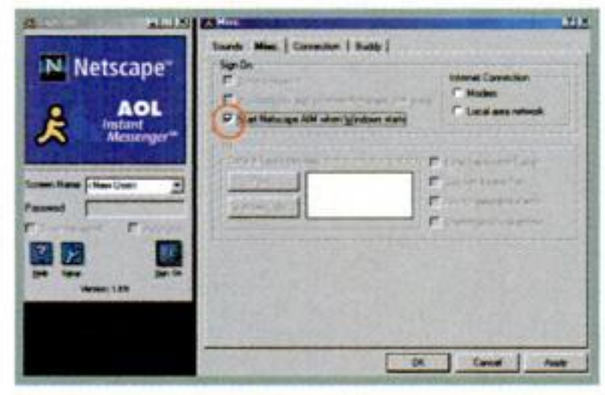
`DisableLog=0 or 1 (default is 0)`
Setting this to 1 enables the creation of a bootlog.txt during startup, for troubleshooting purposes.

`Logo=0 or 1 (default is 1)`
Setting this to 1 enables display of the Windows95 animated logo. Setting to 0 turns it off, over, and out.

TIP 17 Kill the Messenger

HOW IT HELPS

Though it probably didn't come with your computer, chances are that you've installed *Netscape*



TIP 17 — We've all seen the anger-inducing first screen, but how many of you have seen the problem-solving second screen?

Communicator and encountered the annoying *AOL Instant Messenger* (*AIM*) startup screen that automatically launches whenever you reboot. This seemingly inexorable application can be removed, despite the fact it boasts no obvious instructions that suggest otherwise.

HOW TO DO IT

To disable *AIM* so that it won't load unless you explicitly launch it, click on the Setup button on the *AIM* sign-on screen, select the Misc tab, and uncheck "Start *AIM* when Windows starts." To permanently remove the malignant AIM tumor, open up REGEDIT and remove the *AOL Instant Messenger* entry found in the Hkey_Current_User\Software\Microsoft\Windows\CurrentVersion\Run key.

TIP 18 Decompress

You're going to be compressing and decompressing large Internet files all the time, so install *WinZip* and *WinRAR* from the get-go. *WinZip* decompresses the Zip format, is small and easy-to-use, and includes cool right-click and drag-and-drop features that make unzipping a breeze. *WinRAR* works with RAR, a German algorithm that actually allows higher compression ratios than other formats and can create multivolume archives according to size specifications. This allows you to

Copyrighted material

save a single file on multiple floppies. *WinRAR's* ability to compress mongo-large WAV and AVI multimedia files is unsurpassed. Get *WinZip* from **www.winzip.com**. Get *WinRAR* from **www.rarsoft.com**.

TIP 19 Disable autoinsert notification

Autoinsert notification tells your machine to read the AUTORUN.INF file located at the root of CD/DVD-ROM and removable storage drives. This file contains instructions for changing drive icons and launching applications. It's a great aid for novices who don't know how to launch installation apps, but not for people who are constantly swapping discs. At *Maximum PC*, we rue autoplay when we simply want to grab a single file off an installation disc. Autoinsert notification can be disabled on a per-drive basis. Go to Device Manager and double-click on the appropriate drive icon. Hit the settings tab and clear the checkmark for auto insert notification.

TIP 20 Take a Shortcut

To create a popup shortcut in your Start Menu to all of your Control Panel items, open Windows Explorer and head to C:\Windows\Start Menu. From within this directory, create a new folder called Control Panel. Now, launch Regedit by typing REGEDIT in the Start Menu's Run box, and search (under the Registry Editor's Edit menu) for Control Panel. A list of folders should pop up in the lefthand pane of the Registry Editor. Find the only open folder, which should be in the HKEY_CLASSES_ROOT\CLSID tree. The open folder's name should be a really long list of letters and numbers—otherwise known as a CLSID. Grab that CLSID sequence by right-clicking on the folder, choosing Rename, and pressing Ctrl+C to copy the file name. Exit the Registry Editor without making any changes, and head back to the Explorer windows we left open. Rename the folder you originally named Control Panel by appending the text you copied (it should look like "Control Panel.CLSID," where CLSID is the long number you copied). You should now have a fully functional popup copy of the Control Panel in your Start Menu.

TIP 21 Get creative with TweakBIOS

Most motherboards' advanced BIOS settings are hidden. The TweakBIOS utility puts these settings at your fingertips, giving you the ability to change memory timings, latency timers, wait states, memory caching, recovery times, bus-mastering settings, and more—in essence, all things that affect system performance. Download the utility from **www.miro.pair.com**. The shareware version gives you complete access to all functions, except you can't actually apply changes (you'll need the registered version for that). Advanced BIOS settings aren't for the faint of heart, but if you're a seasoned veteran, you can actually boost performance with a few tweaks. (See page 34 for more on BIOS tweaks.)

TIP 22 Use proper CD-ROM settings

For optimal performance, CD-ROM cache settings should be set according to your usage habits. Go to the Performance tab in System Properties. Now hit the File System button under Advanced Settings and click the CD-ROM tab. Adjust Supplemental cache size as needed. Small caches are best for multimedia and gameplay; large caches are best for database and CD-ROM access. For the Optimize access pattern control, leave the setting at "Quad-speed or higher."

TIP 23 Update drivers—Immediately!

Chances are good that the system you just bought was sitting in inventory for months, which means that it's loaded with drivers that are several revisions old. Determine the manufacturers of all your individual components (including your hard drive, CD-ROM/DVD drive, videocard, soundcard, and motherboard), go to the support sections of each manufacturer's web site, and download the latest drivers. New drivers can not only address bugs and glitches, but also add new control panel features and increase performance. Be sure to bookmark each support section so you can return now and then to look for driver updates. And never install drivers meant for another piece of hardware—that's an open invitation for disaster.

TIP 24 Get MIDI Perfect

HOW IT HELPS

Despite the emergence of DirectSound, many games still rely on MIDI (Musical Instrument Digital Interface) to process their musical scores. Most sound chipsets have two MIDI options, and you need to ensure that the best option is enabled.

FM Synthesis is short for Frequency Modulation Synthesis. This is the crappiest form of music reproduction, as your soundcard will attempt to interpret each musical instrument via the same wave-modulation technology that came with your circa-1970's "101 Electronic Experiments" kit. Violins, guitars, and other instruments will sound as if they're being played through a kazoo. Very bad.

Wavetable is the preferred MIDI option, as your soundcard will use actual recorded samples of real-life instruments. The samples can be stored within the soundcard's ROM, or in an external daughtercard or free-standing MIDI box. Violins and glockenspiels sound exactly like violins and glockenspiels. Splendid.

The problem is that many manufacturers will set MIDI processing to FM Synthesis by default, even for great wavetable cards. Bah!

HOW TO DO IT

Go to Control Panel, open Multimedia, and hit the MIDI tab. If your only choice is FM Synth, you're stuck with crap. But if you have other options, such as "External MIDI Port" or "Internal Wavetable," enable one of the devices, open up a MIDI file, and listen to the tunes (the setting for your wavetable device may be labeled with the name of your soundchip—"Montego Wavetable MIDI" or "Monster Sound MIDI Out," for example). If you go with the external option but don't hear anything, you may not have an external device hooked up. Also check your MIDI volume control—it may be set too low.

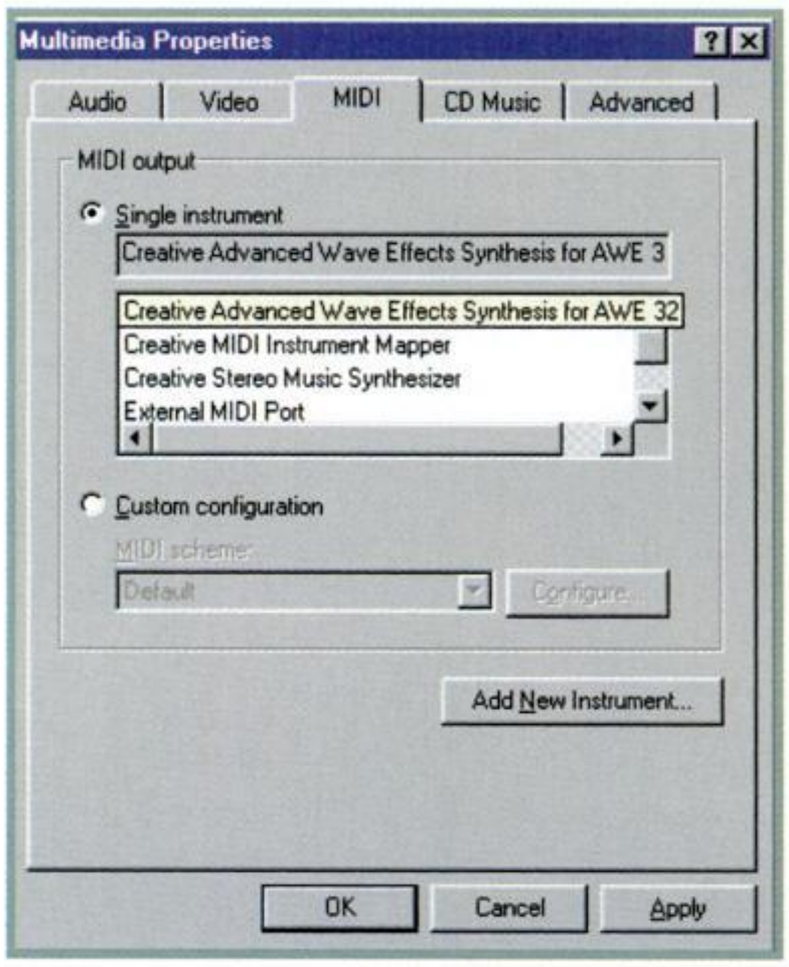
TIP 25 Unload the Bus

HOW IT HELPS

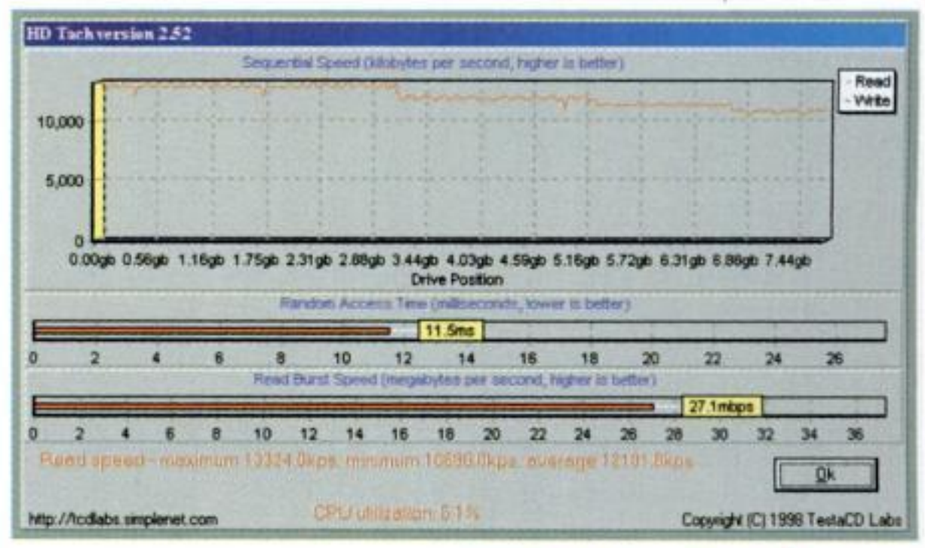
If you have a machine with two hard drives, be sure your regular old EIDE hard drive isn't on the same bus with an UltraDMA drive. When an EIDE drive shares a bus with an UltraDMA drive, the slower EIDE drive will bog the bus down, affecting the faster drive's performance. Slow ATAPI devices, such as CD-ROMs, DVD-ROMs, and removable storage drives should also be moved off the primary bus.

HOW TO DO IT

Most machines have two buses, a Primary and a Secondary (they're labeled on the motherboard). Your boot drive is always the Master device on the Primary bus. This should be the fastest drive you have, since you'll likely be loading Windows and all your apps from here. If your Secondary bus is empty and you have a second device on the Primary bus, move it to the Secondary bus. You'll have to change the Master setting to Slave via jumpers located on the drive.



TIP 24 — Be sure your default MIDI device is anything but synthesis. In this case, you want the AWE32's own instrument samples.


HD Tach version 2.52
Sequential Speed (kilobytes per second, higher is better)
Read
Write
10,000
5,000
0
0.00gb 0.58gb 1.16gb 1.75gb 2.31gb 2.88gb 3.44gb 4.03gb 4.59gb 5.16gb 5.72gb 6.31gb 6.88gb 7.44gb
Drive Position
Random Access Time (milliseconds, lower is better)
11.5ms
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Read Burst Speed (megabytes per second, higher is better)
27.1mbps
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36
Ok
http://hdlabs.simplenet.com
Copyright (C) 1998 TestaCD Labs

TIP 25 — We use ***HDTach*** not only to benchmark hard drives, but also to determine which drive deserves the Master position on the Primary bus.

Copyrighted material

Readers' Tips

In the September 1998 issue, we asked readers to e-mail us their hottest performance tips. Here's a wafer-thin sampling of the top submissions. We received about 4,000 e-mails, and only considered tips that were fresh and original, and those that had somehow slipped under our radar when we were compiling our own list. In cases where different readers sent in the same worthy tip, we chose the first write-up of the tip to arrive in our in-box.

TIP 26 Scrub that registry clean

By running Microsoft's registry cleaning utility every once in a while, you can clean some of the extra crap that programs leave in your Registry when they've been uninstalled. It moves around Microsoft's site on a fairly regular basis, but it can be found by searching at **www.microsoft.com/search** for regclean.exe

—Dillon Cawood

Ed: We like regclean.exe so much that we included it on the CD. It works best for MS programs, but is also effective for certain types of orphaned entries. It's best to make a full registry backup before you do any sort of monkeying around with this tool, as it could cause catastrophic failure, but we've never had any problems.

TIP 27 Virtually faster

To get the best swap-file results, temporarily remove all the shortcuts in your Startup folder, go to the Virtual Memory button under the System Properties performance tab, and disable virtual memory. Now reboot, defrag your hard drive, and set your virtual memory minimum and maximum amounts to the same big fat number. Gurus recommend 2.5 times your system RAM, but about 180MB to 256MB is good. To really get it screaming, invest in Norton Utilities, and use the speed optimizer to place the swap file at the beginning of your hard drive (the fastest part of the drive).

—Sherwin Vischer

Ed: This was one of the most popular tips we received. It conflicts with our own swap-file tip, but it's debatable whether it's best to let Windows set its own swap-file size—it really all depends on the applications you use. Experiment with both tips to determine what works best for you.

TIP 28 Serve me

Go to the Performance tab under System Properties and hit the File System button. Set the typical role of the computer from "desktop computer" to "network server." This usually yields a performance gain in the way Windows allocates resources, leading to more available memory for applications.

—Jason Poe

Ed: Congrats, Jason. You were the first person to send in the most popular tip we received by far. Sort of like the first contestant to ring in with a $100 Jeopardy question.

TIP 29 Caching in

Windows has a cache in which it stores data to be written to the hard drive. The cache doesn't have a set size, and can use up to 31MB of RAM on a 64MB machine. To determine the cache size your computer is using, go to System Monitor and add a monitor for disk cache size under memory managers. You will now be given the amount of memory Windows is using to cache disk writes. If you open the SYSTEM.INI with Sysedit and go to the Vcache section, it will be empty. Add the following lines:

MinFileCache=1024
MaxFileCache=8192

This will set the cache size to 8MB and lower system-resource usage, speeding up disk access. The performance gains are most evident in Unreal and while editing Photoshop files and other memory-hogging programs.

—Michael E. Davis

TIP 30 Memory timing optimizations

Joe Decker of Ithaca, NY, won *Maximum PC's* Dream Machine 98 for his concise, well-written, 2,000-word primer on how to optimize BIOS settings. Here's a small taste of his submission. If you're undaunted by the prospect of getting down-and-dirty with your memory settings, go to **www.maximumpc.com** for the full story—22 tips with background information on all the attendant technology:

The BIOS controls the way all the components in your memory subsystem interact, so adjusting these settings can yield better performance. Before changing anything in your BIOS, write down your current settings in case you crash (or see no performance boost) and need to bring back the original values.

Auto Configuration This setting adjusts all BIOS values to a single default for "best overall performance." Unfortunately, Auto Configuration uses very conservative memory timings that ensure the computer won't freeze or crash while running demanding apps. If you really want to get the most out of your computer, disable this setting. Otherwise, you can't tweak your memory timings.

The Fixed Timing (or Manual) Setting When you enable this setting, you're forced to choose a memory timing that precisely corresponds to the timing of the main memory on your motherboard. As a general rule, there are only three possibilities: 60ns, 70ns, or no value. Using "no value" will allow you to tweak each of your memory timings separately, which is what we're looking for.

DRAM Read Timing Try the lowest values, and if you don't have any problems after running your most demanding applications, you have the right settings for your memory.

DRAM Write Timing This sets write timings and is applied to both FPM and EDO memory. Try the lowest values possible.

Copyrighted material

TWEAK YOUR PC's MOST BASIC SETTINGS FOR POWER AND RELIABILITY

Entering the BIOSphere

Beneath the mundane DOS command prompt and the ornate façade of Windows, there exists a middle ground between hardware and software. This combination of hard-coded computer blueprints and tweakable settings is called the Basic Input Output System, or BIOS, and it sets the rules for how your operating system accesses your CPU, memory, disk drives, videocard, and peripheral slots. The BIOS lives on a Complementary Metal Oxide Semiconductor (CMOS) chip and contains vital information about the computer's configuration. Disk-drive configs, system date and time information, and numerical assignments of DMA channels and interrupt requests (IRQs) to individual motherboard slots and components are all stored in the CMOS chip. If you switch disk drives, put a new card in a slot, or change the date and time in DOS or Windows, the updated BIOS configuration info all lands on the CMOS chip.

The entrance to this subterranean site is a special keystroke that must be pressed as the system boots. The key combination to enter the BIOS setup utility is usually displayed early in the boot process, near the bottom of the startup screen. Del, F2, and Ctrl+Alt+S are the common ones. (If you can't spot the magic key combo, consult your motherboard manual or try hitting the Pause key to freeze the text display on the screen).

Experienced computer users know that BIOS settings can be fine-tuned. Particular settings can control the timing of the CPU and memory chips, set speed limits for the hard disk and videocards, and govern the availability of system resources used by Windows. But to many PC users, the internal workings of the BIOS are a mystery. Most OEM computer vendors treat the subject with Victorian delicacy—a kind of don't ask, don't tell policy. And motherboard manuals generally contain short, cryptic descriptions (if any), written by technical engineers.

To get you the straight dope on what your BIOS settings mean and how they affect system performance, ***Maximum PC*** went straight to the source: BIOS engineers. We selected the Abit BX-6 motherboard with the Intel 440BX chipset and Award BIOS, a popular choice among system builders, then grilled the Award engineers to find out what the complicated labyrinth of BIOS settings means to you. We asked: Can adjusting BIOS settings make your PC faster or safeguard against system crashes? What do you do when Windows stubbornly refuses to recognize your videocard, modem, network card, or USB peripherals?

Keep in mind that you may not find all of the BIOS settings discussed here on your own computer. Generally, computers sold by large OEMs have the advanced BIOS options hidden or removed, the theory being that users (and the OEMs' technical support departments) are better off when the computer's defaults can't be easily altered.

Exercise caution when tinkering with any BIOS settings. Write down all of your current BIOS settings before you change anything. Although the days when one tweak could crash your PC or lock up your BIOS are mostly gone, arbitrary tinkering can still make your hard disk, serial ports, and other hardware components throw fits. Fortunately, most BIOS setup utilities include an option that automatically restores manufacturer defaults.

In the unlikely event that you render the BIOS inaccessible, some computers restore the system defaults if you hold down the Insert key as you flip the power switch. Other computers have hardware jumpers mounted on the motherboard that you can short-circuit to wipe out the CMOS chip. But on some computers, if you set and forget a password, you're toast—it's irreversible. If this is your sorry case, you need to send the motherboard in to the manufacturer to reset it. So be careful.

Bearing all this in mind, a default BIOS option is not necessarily the best option for people who want optimal performance, but it is generally the best option for people who want reliable performance.

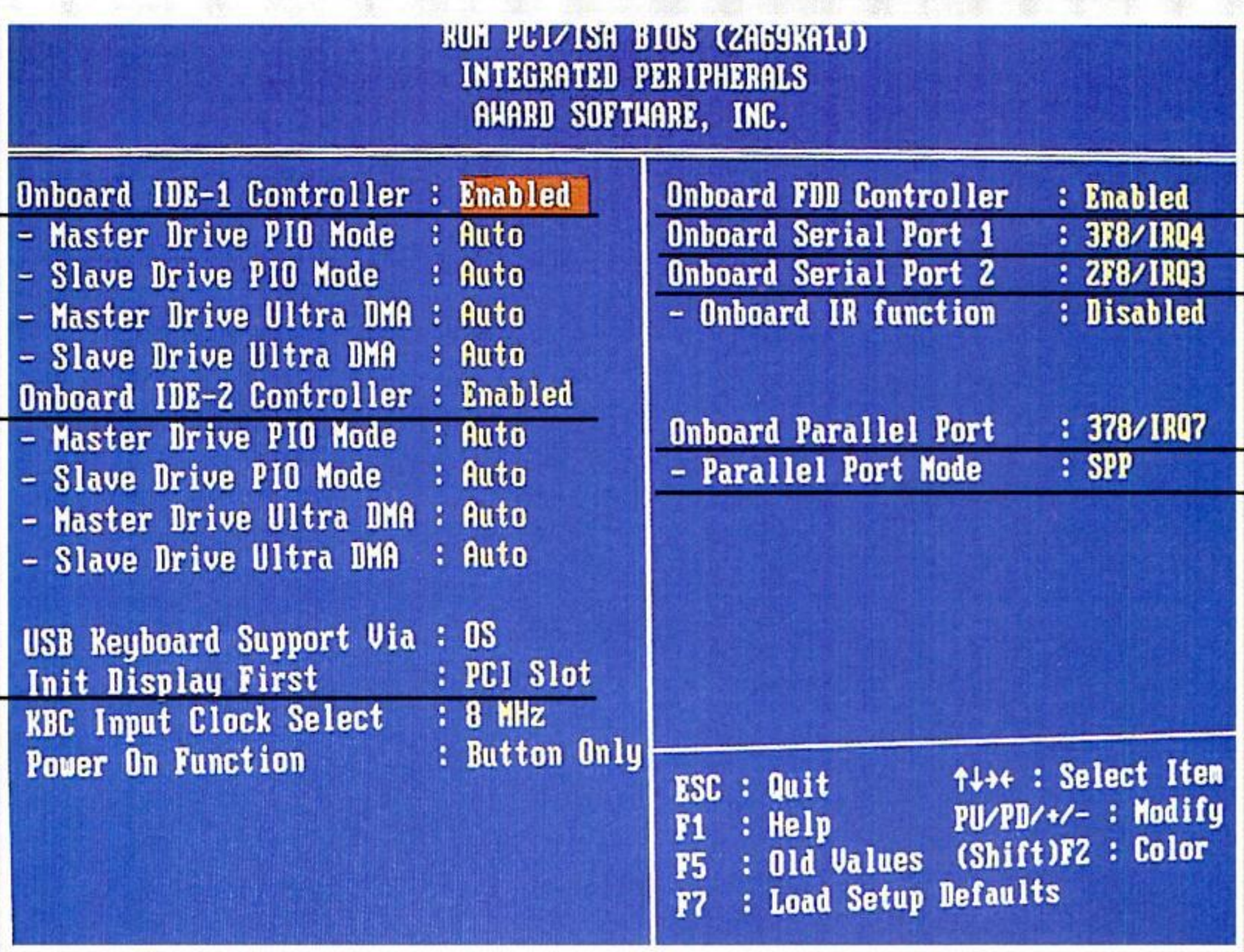
—Lenny Bailes

Copyrighted material

Integrated Peripherals Menu

The Integrated Peripherals screen governs settings that affect onboard I/O devices, such as disk drives, videocards, serial, parallel, and USB ports. Typically, the motherboard will contain a built-in floppy disk controller, primary and secondary IDE hard disk controllers (each supporting two physical drives, a master and slave unit), a USB controller, two serial ports, and a parallel port.

The settings on this screen allow you to enable or disable the various peripheral controllers, adjust the data transfer mode for your hard drive, and modify or disable the computer's parallel and serial ports. For each active peripheral controller or I/O port, Windows generally requires a dedicated port address and hardware interrupt request line (IRQ). Because PCs are equipped with only 15 IRQs, several of which (IRQs 2, 6, and 14) are generally reserved, there are advantages to understanding the settings on this screen. If your PC is loaded with a network card, soundcard, DVD encoder, second videocard, internal modem, or SCSI controller, you can bet your last donut that you'll run out of IRQs, and one or more of these devices may fail to work under Windows. The good news is that if you're not using a motherboard device, such as an IDE controller or serial port, it can be disabled, allowing you to free an IRQ for another device.


ROM PCI/ISA BIOS (2A69KA1J)
INTEGRATED PERIPHERALS
AWARD SOFTWARE, INC.
Onboard IDE-1 Controller : Enabled
- Master Drive PIO Mode : Auto
- Slave Drive PIO Mode : Auto
- Master Drive Ultra DMA : Auto
- Slave Drive Ultra DMA : Auto
Onboard IDE-2 Controller : Enabled
- Master Drive PIO Mode : Auto
- Slave Drive PIO Mode : Auto
- Master Drive Ultra DMA : Auto
- Slave Drive Ultra DMA : Auto
USB Keyboard Support Via : OS
Init Display First : PCI Slot
KBC Input Clock Select : 8 MHz
Power On Function : Button Only
Onboard FDD Controller : Enabled
Onboard Serial Port 1 : 3F8/IRQ4
Onboard Serial Port 2 : 2F8/IRQ3
- Onboard IR function : Disabled
Onboard Parallel Port : 378/IRQ7
- Parallel Port Mode : SPP
ESC : Quit
F1 : Help
F5 : Old Values
F7 : Load Setup Defaults
↑↓→← : Select Item
PU/PD/+/- : Modify
(Shift)F2 : Color
A
B
C
D
E
F

A Onboard IDE Controller (1 and 2)

These settings allow you to disable one (or both) IDE controllers if there are no disks attached to them. It's a handy setting if you're short of system resources. For instance, if you configure the CD-ROM to be a slave drive on IDE Controller-1, you can disable IDE Controller-2, freeing up IRQ 15 for another device. Or, if your computer has a SCSI hard drive and CD-ROM with no IDE devices, you can disable both IDE controllers, freeing up IRQs 14 and IRQ 15.

B Onboard FDD Controller

This toggles recognition of the floppy drive controller on and off for the DOS operating system. One would think that setting this option to "disabled" would stop the floppy disk icon from appearing under Windows 95/98, but it usually doesn't. Newer motherboards have a special setting to accomplish this via the BIOS Features menu.

C Onboard Serial Port 1 and 2

By default, these enable recognition of the first and second onboard serial ports for use with a mouse, external modem, or other peripheral. The auto setting usually defaults to IRQ 4 and port address 3F8 for COM1, and IRQ 3 with port address 2F8 for COM2. If you don't need the serial ports built into the motherboard, you can set these options to "disabled," thereby freeing up a few IRQs for peripherals.

D Init Display First

Your PCI videocard is generally initialized as the primary video controller on your PC, but if you run multiple monitors and want your AGP card to be the boss, you can use this BIOS setting to accomplish this. To use the AGP controller for the primary monitor and the PCI card for an auxiliary monitor, change this setting to "AGP." With the option set to "PCI slot," the PC will recognize the PCI card first, as the primary video controller.

E Onboard Parallel Port

If you don't have a printer, portable drive, or other device attached to your parallel port, you can disable this option to free up an IRQ (usually IRQ 7) for use by another peripheral. If a device currently attached to the parallel port is having trouble under Windows, you can use this setting to switch the default parallel resources from IRQ7/378 to an alternate interrupt/address configuration.

F Parallel Port Mode

Newer printers are generally much faster when the parallel port is set to enhanced COM port (ECP) or enhanced parallel port (EPP) mode. Standard parallel port (SPP) provides backwards compatibility with older printers. Your printer manual should indicate which mode is the best for your printer, but if you can't find this information, try toggling between all of the available modes. If you select ECP mode, the parallel port will use a DMA channel to achieve data transfer speeds as high as 2.5Mb per second, with bi-directional data communication.

Copyrighted material

This is Not Your Daddy's Jukebox

Introducing —

CREATIVE NOMAD® JUKEBOX

All Your Music. Wherever You Go.

Imagine all your music, wherever you go, in one hand-held portable device. Using your computer, you can rip songs from your favorite CDs, download music over the Internet, and store it all on the NOMAD® Jukebox. NOMAD Jukebox holds 150 CDs of digital MP3 music. Built-in EAX™ audio technology and FourPointSurround speaker support give you the ability to customize your music for the most immersive desktop or home audio environment imaginable. Let's face it, all this coupled with intuitive navigation, 6GB of storage, and a line-in jack for recording, makes NOMAD Jukebox the only audio equipment you'll ever need to own.

EAX™

©2000 Creative Technology Ltd. The Creative logo is a registered trademark of Creative Technology Ltd. in the United States and/or other countries. NOMAD is a registered trademark of Aonix and is used by Creative Technology Ltd. and/or its affiliates under license. All brands or product names listed are trademarks or registered trademarks and are property of their respective holders. If you're not on the net, give us a call at 800.998.1000 for more information.

CREATIVE®

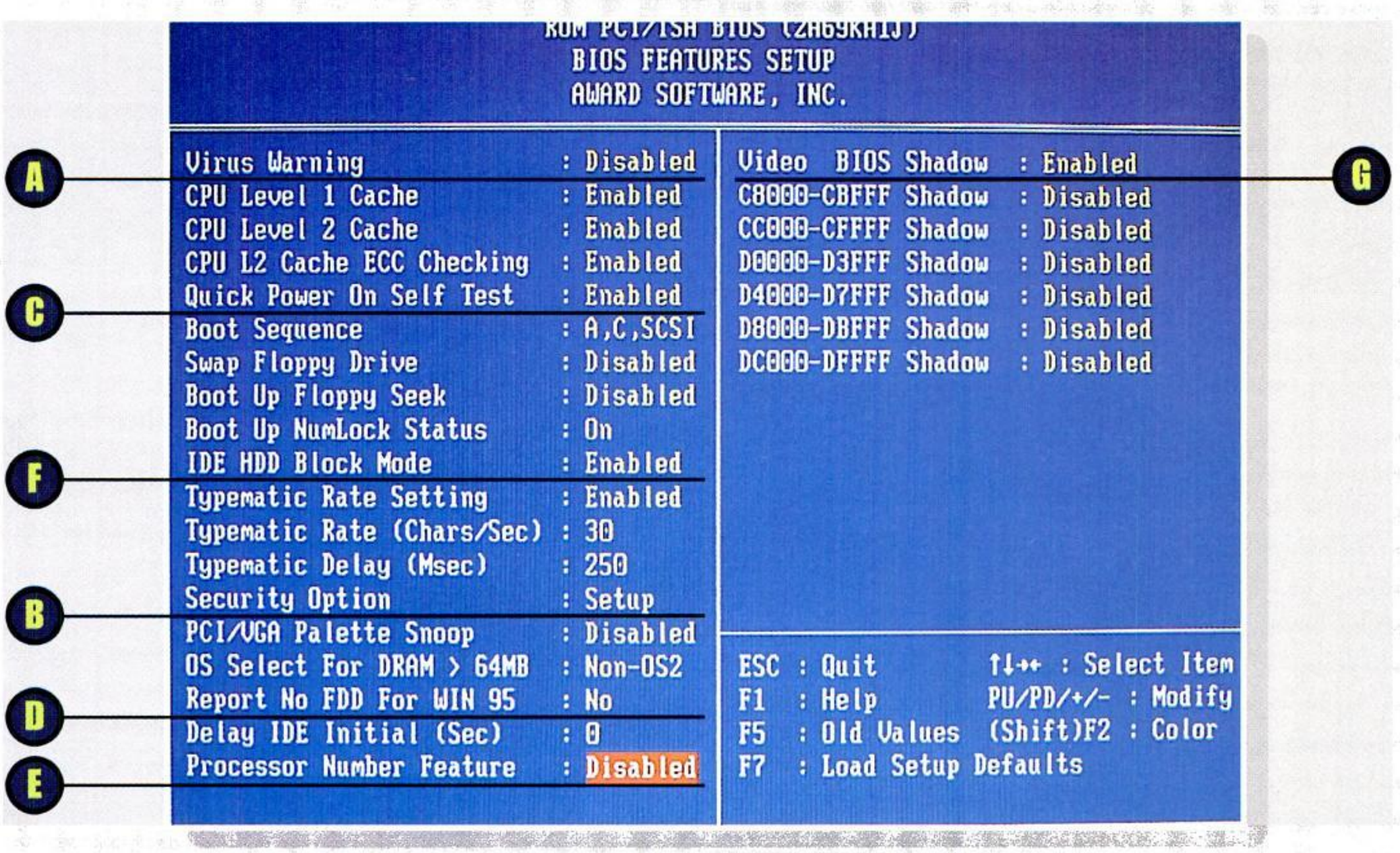
PERSONAL DIGITAL ENTERTAINMENT *Starts Here.*

Copyrighted material

BIOS Features Menu

The BIOS Features menu is full of configuration options intended to let an advanced user customize PC performance—and, unlike some of the other menus, this one has options that are actually useful. It doesn't make much sense to turn off the L1 or L2 cache, for instance, but toggling off the Boot-up Floppy Seek and Quick Power-On Self Test can shave time off your PC's boot process. In the Features menu, you can liven up your IDE hard disk performance by enabling HDD Block Mode, and customize keyboard response with the three Typematic Rate settings. Other options let you enable a simple form of virus protection on your hard disk and specify the access limits of a security password.

A few relics from the 386 days still linger in the Features menu. Video and System BIOS Shadow options made sense under Windows 3.1 and the real-mode DOS operating system, significantly speeding up memory-to-CPU action and video performance. But contemporary hardware under Windows just bypasses the code stored in these locations. If you change your mind about a particular modification, you can press F5 to revert to the previous value or F7 to restore all of the factory defaults.


ROM PCI/ISA BIOS (2A69KA1J)
BIOS FEATURES SETUP
AWARD SOFTWARE, INC.
Virus Warning : Disabled
CPU Level 1 Cache : Enabled
CPU Level 2 Cache : Enabled
CPU L2 Cache ECC Checking : Enabled
Quick Power On Self Test : Enabled
Boot Sequence : A,C,SCSI
Swap Floppy Drive : Disabled
Boot Up Floppy Seek : Disabled
Boot Up NumLock Status : On
IDE HDD Block Mode : Enabled
Typematic Rate Setting : Enabled
Typematic Rate (Chars/Sec) : 30
Typematic Delay (Msec) : 250
Security Option : Setup
PCI/VGA Palette Snoop : Disabled
OS Select For DRAM > 64MB : Non-OS2
Report No FDD For WIN 95 : No
Delay IDE Initial (Sec) : 0
Processor Number Feature : Disabled
Video BIOS Shadow : Enabled
C8000-CBFFF Shadow : Disabled
CC000-CFFFF Shadow : Disabled
D0000-D3FFF Shadow : Disabled
D4000-D7FFF Shadow : Disabled
D8000-DBFFF Shadow : Disabled
DC000-DFFFF Shadow : Disabled
ESC : Quit
F1 : Help
F5 : Old Values
F7 : Load Setup Defaults
↑↓→← : Select Item
PU/PD/+/- : Modify
(Shift)F2 : Color
A
B
C
D
E
F
G

A Virus Warning

Enabling this setting installs a watchdog on the boot sector of your hard drive that intercepts and alerts you when anything tries to overwrite the boot sector or partition table. This provides quick-and-dirty protection against boot-sector viruses but can cause problems when you try to upgrade your OS or run any disk maintenance software, such as Symantec's *Norton Utilities*. However, you'll need to disable this setting every time you defrag. This is not an acceptable substitute for a full-featured antivirus package, so don't try any hot-and-heavy PC work with only this BIOS setting to protect you.

B Security Option

This setting works in conjunction with the password option (which, on this motherboard, is located on the main BIOS screen). If you've created a password, setting this option to "system" will make the computer ask for a password each time the system boots up, before the OS is permitted to load. If you change the option to "setup," the computer will only prompt for a password when someone attempts to enter the CMOS configuration screens.

C Quick Power-On Self Test

You can disable this option to make the computer skip some of its internal diagnostic tests at startup. This speeds up the boot process. The drawback is that you lose your early warning system if memory chips or other components are about to fail.

D Report No FDD for Windows 95

By selecting "yes" on this option, Windows 9x is duped into thinking that your computer has no floppy disk controller, freeing up IRQ 6 for use by other peripherals. If you're running without a floppy drive (for instance, on a notebook computer), you should set this to "yes" and toggle the onboard floppy controller to "no" in the integrated peripherals menu.

E Processor Number Feature

This feature is only active when your computer has a Pentium III processor installed. Intel raised the ire of surveillance-resistant users everywhere last year when it designed the Pentium III to automatically report its serial number to Windows 98 for monitoring by external applications. The default setting of "disabled" suppresses this feature, to protect your privacy.

F IDE HDD Block Mode

This setting (also called 32-Bit I/O) speeds up IDE drives when enabled by allowing multiple sector read/write operations. Most IDE drives manufactured in the last several years support Block Mode under Windows 95 and 98. However, under Windows NT Workstation or Server, Microsoft recommends that you disable this setting to avoid data corruption.

G Video BIOS Shadow

When this legacy feature is enabled, code is copied in the video section of your system's BIOS from ROM into RAM memory. Under DOS, this sped up the screen display for games, but it has no effect under Windows 95/98. DirectX and OpenGL games bypass the system BIOS and write directly to the video hardware. Some computer vendors warn that enabling this option may decrease the stability of the system, since ill-behaved games may overwrite video instructions cached in RAM.

Copyrighted material

Total PC surge protection for only $5 per outlet.

At $40, APC's SurgeStation™ protects up to 8 devices from damaging surges and spikes, for life.

Lightning storms, overloaded circuits, electrical surges can destroy computers, TVs, sound systems, and VCRs in a flash, whether they are on or not. This is especially true during summer months. An APC SurgeArrest® is your ironclad guarantee that valuable electronic components stay alive, regardless of bad weather or other unexpected power problems.

In fact, if you experience a high voltage power surge, an APC unit will sacrifice its life for your equipment. Our Lifetime Guarantee means you'll receive a brand new replacement SurgeArrest, free of charge, usually within 48 hours. So your expensive electronics survive unharmed and you receive a brand new APC to boot!

Join 8,000,000 customers who already rely on APC power protection today.

APC SurgeArrest® SurgeStation™ Pro8T2: complete surge protection for your entire system.

APC was chosen by PC Magazine as one of the "Top 100 Technology Companies That Are Changing The World" (10/99).

A SurgeArrest SurgeStation gives you:

- Eight (8) outlets to protect your computer, displays, printers, scanners and more (3 spaced outlets for transformer blocks)
- Telephone/Internet protection* safeguards from telephone line surges
- Green "Protection Working" LED lets you know that your SurgeArrest works perfectly
- Red "Site Wiring Fault" LED automatically detects potentially dangerous wiring problems in the wall circuit
- Cable/TV/Video protection* safeguards from cable modem line surges
- Up to $25,000 in Equipment Protection Policy (U.S. and Canada only). *(See policy for details)*
- APC will replace your SurgeArrest free of charge under its Lifetime Product Guarantee

** select models*

Notebook Surge Protection for only $59

The PNotePro family protects your notebook from power and telephone surges anywhere in the world.

PC Power Protection for only $79

The Back-UPS® Office provides your PC with surge protection and battery back-up to save your work and shut down properly.

Workstation Power Protection for only $149

The Back-UPS Pro® USB provides advanced power protection, AVR for extended runtime, and is compatible with Windows® 98.

APC®
Legendary Reliability™

You can find APC power protection products at these stores or visit *http://promo.apcc.com* and click on "how to buy" to find your nearest reseller.

energyOn.com™ The World's Online Energy Store™ · CIRCUIT CITY · PC Connection 800-986-2320 · UP buyTIME.com · STAPLES The Office Superstore

Official Power Protection of USA Cycling

APCC™ A Nasdaq-100 Company

FREE APC T-shirt for the first 100 entrants. One lucky winner will receive a FREE APC UPS.

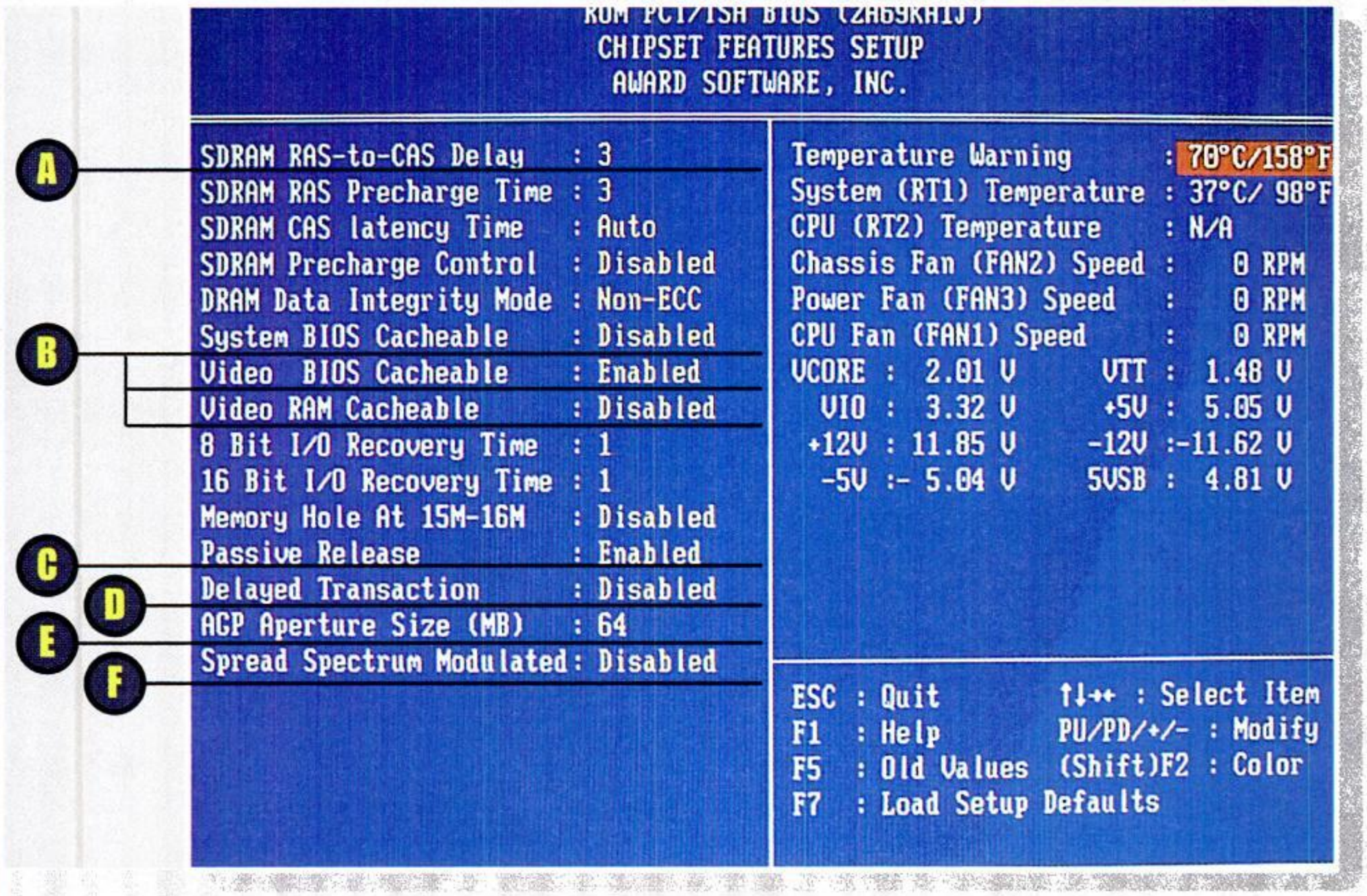
To order: Visit *http://promo.apcc.com* Key Code v144z • Call 888-289-APCC x8751 • Fax 401-788-2797

©2000 American Power Conversion. All Trademarks are the property of their owners. APC4AØCF-US • PowerFax: (800) 347-FAXX • E-mail: apcinfo@apcc.com • 132 Fairgrounds Road, West Kingston, RI 02892 USA

Copyrighted material

Chipset Features Menu

The Chipset Features menu contains settings that relate primarily to timing issues for read and write operations to memory and the system bus. In the early days of 386 and 486 motherboards, you could sometimes gain significant PC performance advantages by tweaking these settings. On contemporary motherboards, there's much less to be gained by manipulating BIOS such settings as SDRAM-to-CAS Delay, SDRAM RAS Precharge Time, and SDRAM CAS latency time. And tweaking the System BIOS and Video BIOS caches may sound like a good idea until you realize that today's protected-mode OSes rarely access this code after the initial PC boot sequence. On the other hand, the Chipset Features menu contains a series of ISA-to-PCI settings that can be tweaked to improve overall system performance. By default, the motherboard will often slow down or suspend PCI bus operations when an ISA peripheral is accessed. This setting, along with the 16-bit I/O Recovery Time, Passive Release, and Delayed Transaction settings, can be tweaked to redefine the relationship between the PCI and ISA data buses, so that your PCI cards are never forced to wait for some stanky-ass old ISA card. AGP Aperture Size is another setting on this menu that has generated a lot of heated debate on web sites and gamer newsgroups. Some people advocate overallocating this setting to improve the robustness of games and 3D video. But the AWARD Engineers set us straight on this issue: Leave this setting at 64MB unless the videocard manufacturer recommends something different.


ROM PCI/ISA BIOS (2A69KA1J)
CHIPSET FEATURES SETUP
AWARD SOFTWARE, INC.
SDRAM RAS-to-CAS Delay : 3
SDRAM RAS Precharge Time : 3
SDRAM CAS latency Time : Auto
SDRAM Precharge Control : Disabled
DRAM Data Integrity Mode : Non-ECC
System BIOS Cacheable : Disabled
Video BIOS Cacheable : Enabled
Video RAM Cacheable : Disabled
8 Bit I/O Recovery Time : 1
16 Bit I/O Recovery Time : 1
Memory Hole At 15M-16M : Disabled
Passive Release : Enabled
Delayed Transaction : Disabled
AGP Aperture Size (MB) : 64
Spread Spectrum Modulated : Disabled
Temperature Warning : 70°C/158°F
System (RT1) Temperature : 37°C/ 98°F
CPU (RT2) Temperature : N/A
Chassis Fan (FAN2) Speed : 0 RPM
Power Fan (FAN3) Speed : 0 RPM
CPU Fan (FAN1) Speed : 0 RPM
VCORE : 2.01 V
VTT : 1.48 V
VIO : 3.32 V
+5V : 5.05 V
+12V : 11.85 V
-12V : -11.62 V
-5V : - 5.04 V
5VSB : 4.81 V
ESC : Quit
↑↓→← : Select Item
F1 : Help
PU/PD/+/- : Modify
F5 : Old Values
(Shift)F2 : Color
F7 : Load Setup Defaults
A
B
C
D
E
F

A SDRAM-RAS-to-CAS Delay

This setting tweaks the delay between two electronic signals transmitted to the RAM installed on the motherboard, the Row Address Strobe (RAS) and the Column Address Strobe (CAS). The number indicates how many clock cycles the memory needs in order to prepare for another transaction. Reducing this setting from 3 to 2 might speed up memory performance, but if you experience stability problems, change it back.

B System BIOS, Video BIOS, Video RAM Cacheable

These options allow the system BIOS ROM, Video BIOS, and Video RAM to be copied to your L2 cache, which is considerably faster to access than the motherboard's ROM. This would make the system run faster if Windows actually used this ROM much after the initial boot sequence. But in reality, Windows seldom (if ever) does this. Since your L2 cache is limited in size and space is at a premium, we recommend that you leave this setting disabled.

C Passive Release

This setting controls the CPU's access to the PCI bus when a peripheral on the ISA bus is in use. If Passive Release is enabled, the CPU can read from and write to the PCI bus concurrently with data transfers along the ISA bus. If the option is disabled, the CPU must access the PCI bus through a PCI bus master when ISA cards are being used. In general, enabling this option will speed up performance. It should only be disabled if you experience problems with the operation of ISA cards.

D Delayed Transaction

You should enable this option for faster performance with ISA peripherals, and disable it only if you experience problems. When the CPU is accessing the ISA bus, PCI cycles take a longer time to complete, even with the Passive Release BIOS setting enabled. To further compensate for this bottleneck, you can enable Delayed Transactions. This creates a write-buffer in the motherboard's chipset that can synchronize ISA and PCI transactions, allowing the ISA bus instruction to send to the CPU while the PCI bus is active.

E AGP Aperture Size

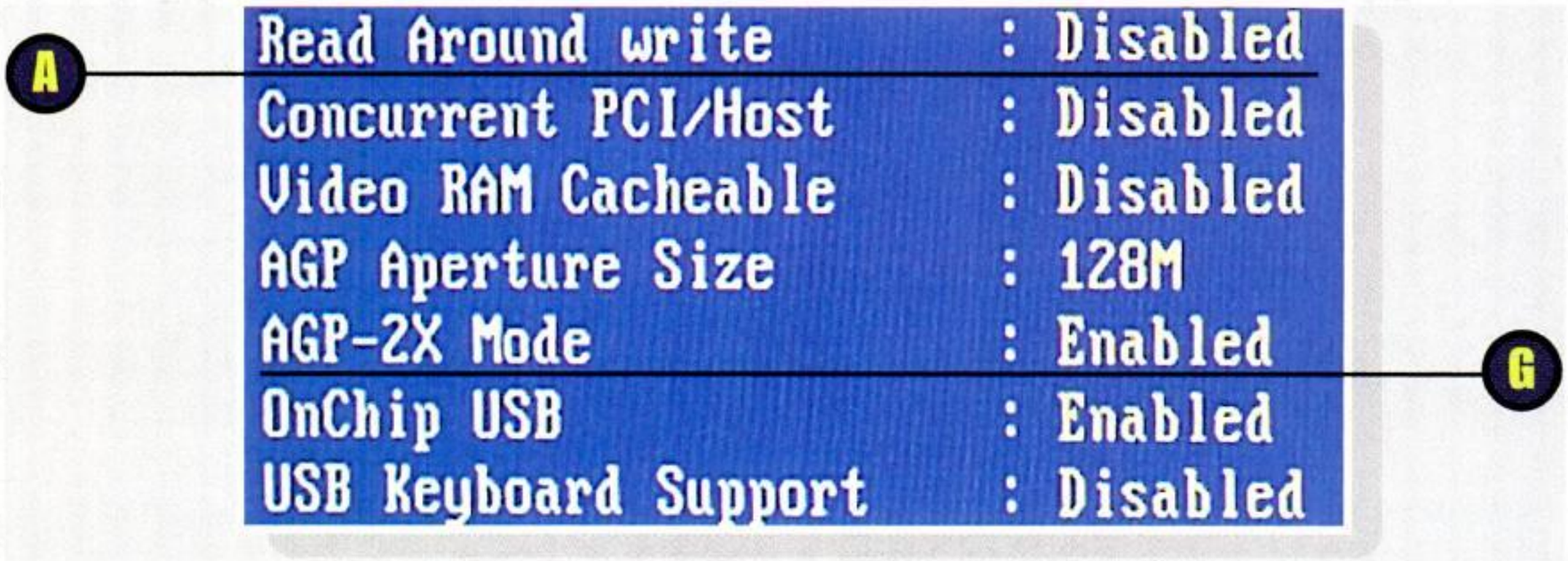
The AGP aperture is a reserved portion of the PCI memory address space that's used to store 3D vertex and texture map data. This corresponds to the actual amount of system RAM in the computer (from 4MB to 256MB) that can be allocated to the videocard, and should correspond to the instructions bundled with your AGP card. In general, a setting of 64MB should be optimal, unless the vendor recommends more.

F Spread Spectrum Modulated

This option is designed to modulate spikes of electromagnetic interference (EMI) that might be produced by a motherboard's clock generator. Enabling it in some BIOSes activates a "smart clock" feature that turns off AGP, PCI, and SDRAM signals when these components are not in use, thereby reducing the potential for EMI. Award cautions that enabling this setting can decrease system stability, so you should leave it disabled unless your computer is experiencing heavy electromagnetic interference.

Copyrighted Material

Other Settings



A Read Around Write
This feature, found in some AWARD BIOSes, can speed up system performance slightly by allowing the CPU to execute read commands directly from the L2 cache on the contents of an address before its latest contents are actually transferred to system memory. According to AWARD, the performance increase is only .0001 percent, but some hardware gurus recommend enabling it anyway, since the impact on stability is minimal.

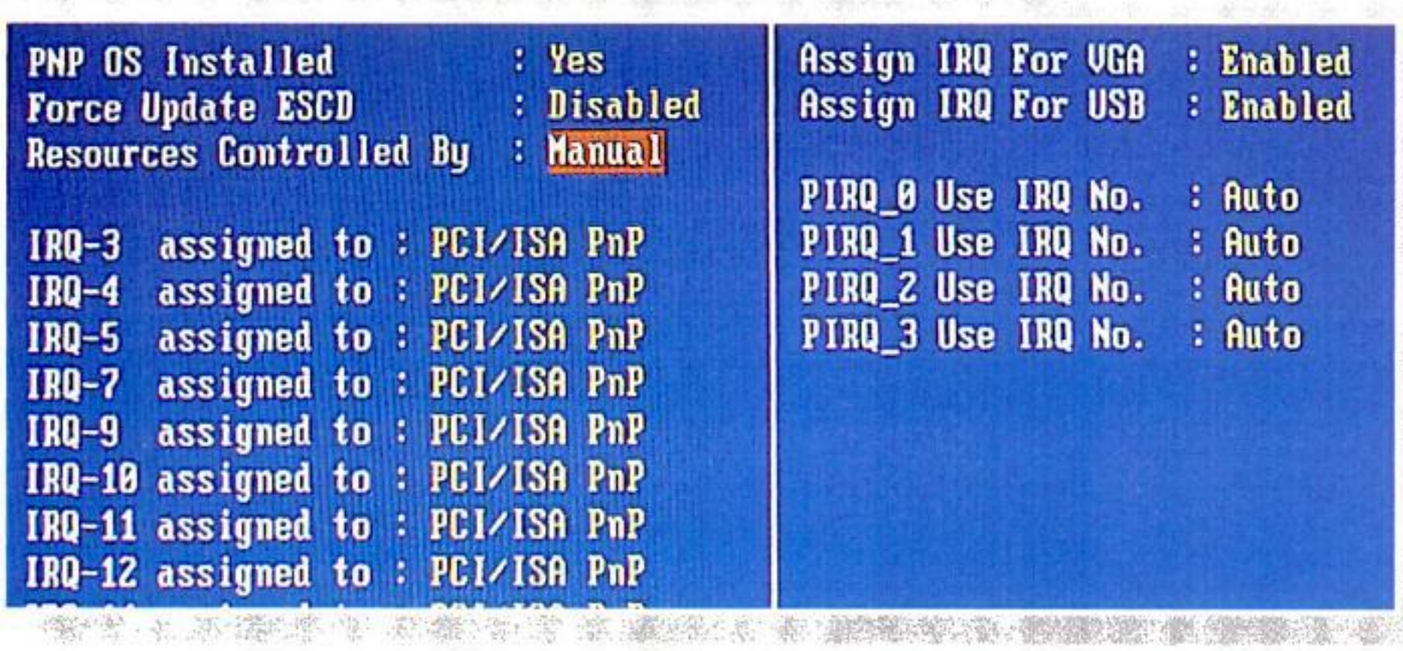
B AGP 2x Mode
There are several generations of AGP graphics adapters currently in circulation, with 1x-, 2x-, and 4x-speed configurations. Some motherboards detect the AGP card and automatically assign it the highest speed supported by the internal chipset. Others include this option in the BIOS, which allows you to speed up or slow down the default setting. (The most recent motherboards offer a corresponding AGP 4x option.) If your videocard supports AGP 2x or AGP 4x data transfers, be sure this BIOS setting is configured appropriately to get the most out of your card. But if you're experiencing compatibility problems, such as applications or games crashing, you can try to bump the setting down to stabilize the system.

Turning Plug-and-Pray into Plug-and-Play

Intel developed its PCI Plug-and-Play motherboard standard before Microsoft integrated Plug-and-Play support into Windows 95. Each standard provides a way for your PC to dynamically assign resources—you can choose between your BIOS ("the devil"), or Windows ("the deep blue sea"). The toggle switch is in your BIOS; it's a simple yes/no setting in the PNP/PCI configuration menu called "Plug and Play OS." When set to yes, the "Plug and Play OS" setting puts the BIOS configuration options to sleep, handing to Windows the task of dynamically assigning IRQs, DMAs, and port addresses to the peripherals installed on the PCI and ISA buses. Sometimes this works out well. Other times, Windows might make you want to smash your head into your monitor when the Device Manager refuses to let you change COM 2 to COM1, IRQ 5 to IRQ 7, or port address 3BC to 378, taunting you with an immutable message that reads, "This resource cannot be modified."

Your motherboard may be smarter than Windows 98. To find out, you can set the "Plug and Play OS" setting to no, and reboot the computer. The system hardware will assign each IRQ to a slot, and Windows will dutifully abide. But you may still run into problems. With the BIOS dictating your resource assignments, Windows can't dynamically reassign them. But occasionally, Windows can shift an interrupt. Say your network card draws IRQ 10, but it needs IRQ 5. Since the BIOS has already assigned the card IRQ 10, there's no IRQ left for the USB controller, and it still has a big exclamation point next to it in the Device Manager list. Windows doesn't turn the card on, so turn PNP to no. If it replies that interrupts are not available, go into the BIOS and reserve an IRQ.

Your third alternative is to toggle the "resources controlled by" option on this menu from Auto to Manual. A list of all the IRQs on the computer will appear, allowing you to assign each one to either the PCI/ISA Plug and Play bus or the legacy ISA bus. What this means in practical terms is that if you have a 3Com Etherlink III ISA Plug and Play network card that refuses to work, both Windows and the motherboard may be snubbing it at boot time, failing to detect its existence on the PCI bus. This is because the card is actually on the ISA bus. The card's properties in the Windows Device Manager may report failure due to lack of an available interrupt. But the complete list of interrupts in the Device Manager shows IRQ 10 unassigned. To remedy this situation, you can open the CMOS settings to the PNP/PCI Configuration Menu, choose Resources Controlled by "Manual," and toggle the "IRQ 10 Assigned to" setting from "PCI/ISA PNP" to "Legacy ISA." (The option may be worded slightly differently in some BIOS configurations, but the idea is the same.) Save the settings, reboot the computer, and the network card will work.


PNP OS Installed : Yes
Force Update ESCD : Disabled
Resources Controlled By : Manual
IRQ-3 assigned to : PCI/ISA PnP
IRQ-4 assigned to : PCI/ISA PnP
IRQ-5 assigned to : PCI/ISA PnP
IRQ-7 assigned to : PCI/ISA PnP
IRQ-9 assigned to : PCI/ISA PnP
IRQ-10 assigned to : PCI/ISA PnP
IRQ-11 assigned to : PCI/ISA PnP
IRQ-12 assigned to : PCI/ISA PnP
Assign IRQ For VGA : Enabled
Assign IRQ For USB : Enabled
PIRQ_0 Use IRQ No. : Auto
PIRQ_1 Use IRQ No. : Auto
PIRQ_2 Use IRQ No. : Auto
PIRQ_3 Use IRQ No. : Auto

If you don't want to leave your precious hardware resources in the clutches of Windows, you can go old-school by manually assigning resources.

Copyrighted material

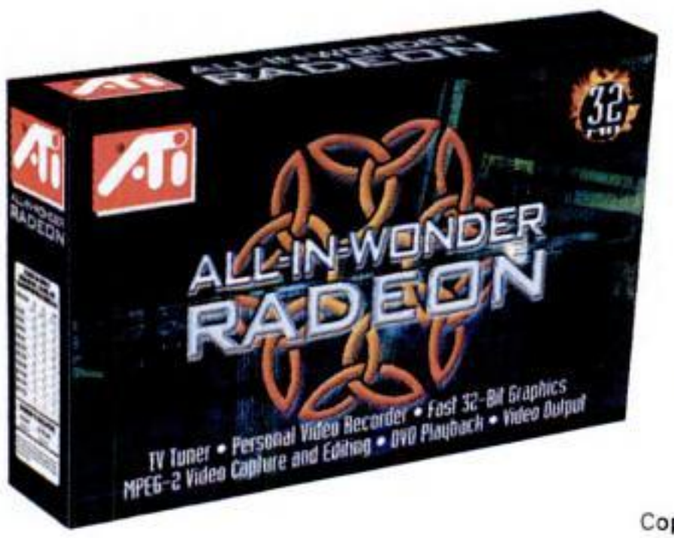
ATi RADEON GRAPHICS™

Gimme WONDER!

Amazing! The fastest 3D graphics *plus* interactive TV and video editing all in one upgrade.

Nothing seems impossible when you're in control of the most powerful TV, VIDEO and GRAPHICS upgrade there is – all in one, single card. The ALL-IN-WONDER® RADEON™. Now you have the features you need to work wonders on your PC and the performance to play the most advanced 3D games with ultra-fast frame rates.

How could we improve the famous ALL-IN-WONDER®? — with RADEON™ Graphics and new features like TV-ON-DEMAND™ timeshifting and a free Interactive Program Guide. Of course you can still edit your own home movies, experience the best DVD playback with Dolby® Digital 5.1 surround sound and much more.


ALL-IN-WONDER RADEON
32
ALL-IN-WONDER
RADEON
TV Tuner • Personal Video Recorder • Fast 32-Bit Graphics
MPEG-2 Video Capture and Editing • DVD Playback • Video Output

Just say GIMME WONDER and you can have it all. Visit ati.com today for more ALL-IN-WONDER® facts and feature information.

Copyright 2000, ATI Technologies Inc. All rights reserved. ATI, ALL-IN-WONDER, ALL-IN-WONDER RADEON and RADEON are trademarks and/or registered trademarks of ATI Technologies Inc.

Visit ati.com

Copyrighted material

Ultimate Upgrade Bible

Maximum PC readers, do not ignore the signs that your PC is on a dangerous path to obsolescence: Your venerable hard drive has grown slow and feeble, your videocard cowers in the face of the latest games, and your CPU cannot contend with the 1GHz monsters that your neighbors have acquired. You are the power users, the PC elite, the Chosen People—and the time of reckoning is upon you. Thou shalt covet thy neighbor's superior hardware!

There's no need to scrap your current machine for a brand-new PC when replacing a few of your key components can make all the performance difference in the world. For instance, you may have a videocard that pushes more geometry than a high-school textbook, but you won't realize its full potential until your hard drive spins fast enough to keep your system fed. Keep in mind that your PC is only as fast as its slowest bottleneck, so don't overlook less glamorous components in your quest to have the fastest clock on the block.

On the other hand, don't get carried away—the idea is to choose your upgrades wisely, not necessarily to replace every piece you can get your hands on. Sometimes, the latest and greatest hardware doesn't make the best upgrade. You can ante up a king's ransom for a gigahertz CPU, but you may be better off finding a reasonably priced 800MHz processor and sinking your savings into a fat soundcard and CD-RW drive.

Consider what you do with your PC, then decide whether more memory, a new CPU, or a new hard drive will help you do it better. There's something to be said for buying ahead of the curve and growing into the capabilities of state-of-the-art hardware, but paying for advanced features that you can't or don't take advantage of is a foolish choice.

Our Ultimate Upgrade Bible will guide you in your search for the component upgrades that will make the largest impact on your PC. It will help you decide how long to hang on to your current parts, and when to replace them—and whether you should replace them with components that are available right now or wait for the next big thing.

Thou shalt not accept inferior hardware. Thou shalt turn your aging rig into a fast, furious system that is worthy of you. Go forth and multiply!

Copyrighted material

CPU and Motherboard

These days, swapping out a CPU is akin to shoving a 440-cubic-inch engine into a Volkswagen Beetle. It's no longer just a matter of upgrading the CPU; now, there's the question of whether all the surrounding components will need to be replaced as well. A new CPU will most likely require a new motherboard, which in turn will require different RAM, and maybe even a different case. Then there's the new hard drive and videocard you'll want to buy in order to take full advantage of the advanced features supported by the new motherboard chipset. And since so much depends on the CPU and chipset, choosing the right motherboard and processor combo is the most crucial upgrading decision you'll face.

If you were smart enough to buy a 440BX-based motherboard when you built your 266MHz machine in 1998, you could be in luck when it comes time to upgrade. If the mobo supports the Coppermine's lower voltage requirements, it can theoretically run a 1GHz CPU. Intel's newer Coppermine Pentium IIIs (700MHz and faster) require lower voltage settings. If your motherboard can't support these lower voltages, you should at least be able to run a 600MHz Pentium III in your BX mobo. Visit your motherboard manufacturer's web site for the full skinny. Fans of the 440BX should be advised that upcoming AGP 8x cards will only be compatible with AGP 4x mobos. This means that your next videocard may not work with your beloved BX.

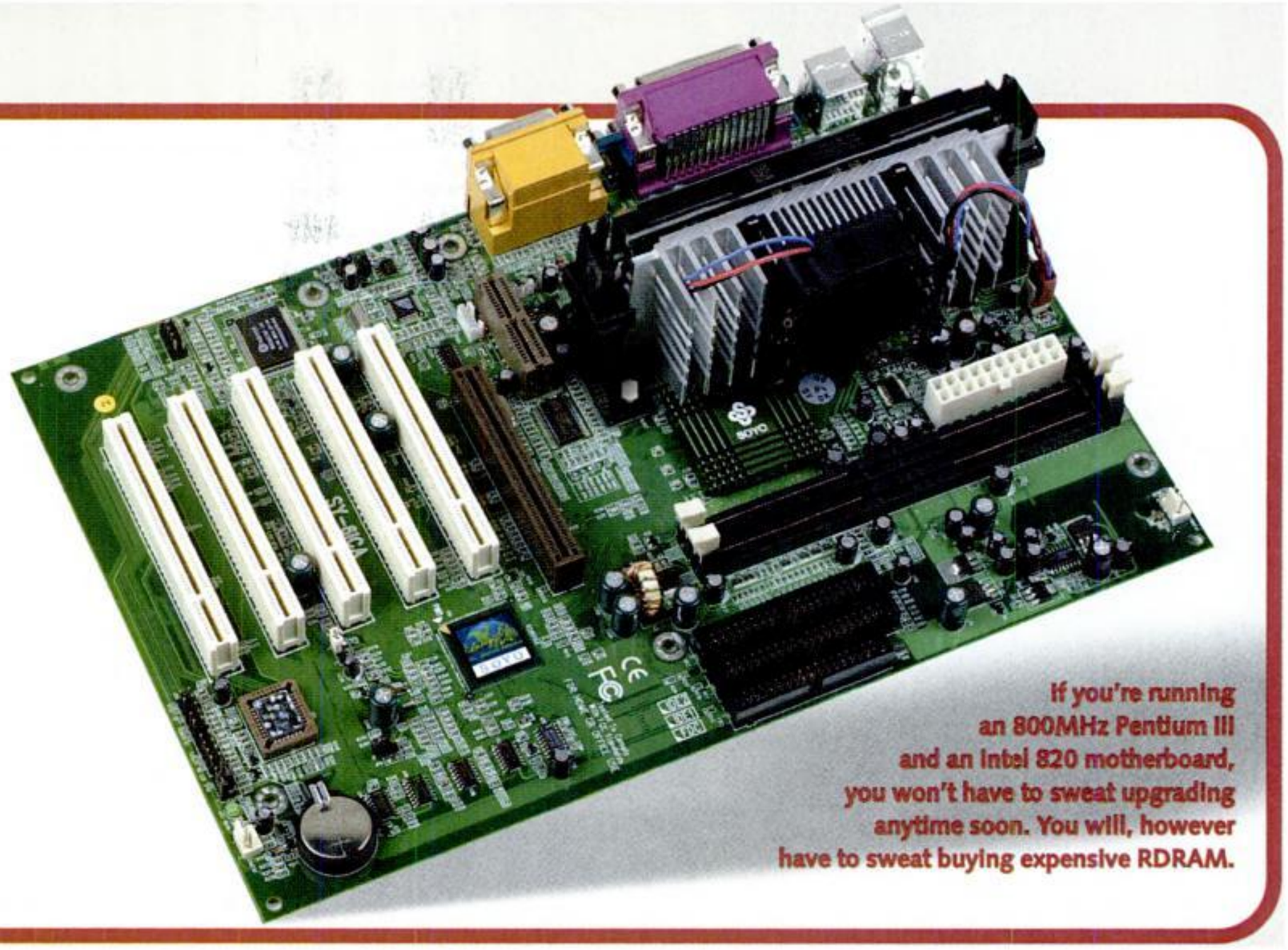
The vagaries governing which CPU you can use with your chipset and motherboard are as complex as the tax code. Intel's Pentium II and III processors mate well with the 440BX, 815, and 820 chipsets, while Celerons are generally better suited to the 810, 440ZX, and 440LX chipsets. Combine a Pentium II with a 440LX motherboard and you'll top out at 333MHz. Put a Celeron into that same mobo and you can cruise at 500MHz. Again, check your motherboard manual to find out what it supports.

If you waded into the murky Athlon waters with an early 550MHz Athy, you're in good shape; almost every Athlon AMD 750-based motherboard appears to support up to 1GHz CPUs, in both their original form and the souped-up Thunderbird incarnation. Getting a Slot A Thunderbird may pose a serious problem, however, since AMD will only sell the Slot A CPUs to system OEMs. Boxed Thunderbird processors are only available in AMD's new-fangled connector dubbed the Socket A, which doesn't work with Slot A motherboards. Of course, the really bad news is for early adopters who purchased boards based on VIA's KX133 chipset. Due to some massive brain fart at VIA, AMD, or both, the new chipset has some compatibility issues with the Thunderbird Athlons. It's not that a KX133 won't work with Thunderbird—it's just that compatibility isn't really a sure thing. Some KX133 peeps report absolutely no problems. If you plan to upgrade our Athlon mobo, getting something based on VIA's fixed KT133 chipset (formerly KZ133) will save you a lot of headaches.

What's the minimum-speed CPU you should buy? 1GHz. Too rich for your blood? We recommend at least 800MHz for all new machine purchases. That might sound high, but in our opinion, buying the most powerful components you can afford protects your investment in the long term. After all, if you purchased a 266MHz Pentium II two years ago instead of going with a 400MHz Pentium II, you saved $600 back then, but you now own a worthless proc. The 400MHz system is still serviceable. It goes without saying that you should avoid core-logic chipsets and bus speeds that are clearly on the way out, but we'll say it anyway.

If you're looking for a motherboard that'll carry your PC into the future, Yoda can't say—set, the future is not. Intel's 815e chipset appears to be very worthy of carrying the Pentium III without breaking the bank for Direct RDRAM. Of course, by the time you read this, the Pentium 4 will be unleashed and all bets will be off. The P4 will be coupled with the new 850 chipset, a dual channel Direct RDRAM chipset. As for AMD, its new 760 and 760MP chipsets threaten to make all current Athlon chipsets look like chumps.

If you must make a mobo purchase, we recommend Intel's 815e chipset or VIA's Apollo Pro 133A for Pentium-based PCs. If you want to buy RAM that'll work when you upgrade to Pentium 4, a board that uses the Intel 820 chipset and RDRAM is the only logical choice. For Athlons, look to VIA Technologies' KT133, the successor to VIA's screwed-up KX133. It's free of the bugs that plagued the old chipset, and it works with the faster Thunderbird CPUs. VIA is also set to unleash chipsets using Double Data Rate SDRAM that could make short work of RDRAM. (For more on mobo chipsets, see "Chipset Shop Talk" on page 83.)



If you're running an 800MHz Pentium III and an Intel 820 motherboard, you won't have to sweat upgrading anytime soon. You will, however have to sweat buying expensive RDRAM.

CPU Upgrades

IF YOU HAVE...	UPGRADE TO...
166MHz Pentium/233MHz K6-2/266 MHz	P-III 800+MHz Pentium or Athlon CPU
Intel Pentium III 500MHz	Wait for Intel's Pentium 4 before making a jump, or make the switch to an AMD Thunderbird.
AMD Athlon 700MHz	You have a state-of-the-art CPU architecture. Look to improve speed at other bottlenecks, such as the hard drive, videocard, and RAM.

Motherboard Chipset Upgrades

IF YOU HAVE...	UPGRADE TO...
Socket 7 or 440LX mobo	KT133/i820/i815e/ Apollo Pro 133A-based mobo
440BX	Don't retire this workhorse if it can support Coppermine voltages.

Monitor

Unless you just gaffled Regis for his untold millions, your monitor purchase will be the most sensitive upgrading decision you make. Because good monitors are extremely expensive compared to other parts, most people upgrade them just once every three or four years. If you fall into this category, buy the best monitor possible when you finally do take the plunge. Don't avoid expensive displays out of sheer stinginess, because you'll be living with your monitor long after you've junked your other parts.

All CRT monitors are based on one of two technologies: shadow mask or aperture grille. Shadow mask monitors run cheaper, but tend to offer darker screens and less vibrant colors than their aperture grille cousins. The reason is simple: Shadow mask monitors filter out a greater number of electrons than aperture grille monitors are able to, and therefore allow less light to reach your eyes. Shadow mask monitors can also suffer from screen purity problems

Copyrighted material

Don't let your CD sessions go to the dogs

If you've got an inefficient drive—and there are many around—excessive speed during a burn session can kill a disc. The faster the drive attempts to burn, the harder it becomes for the drive's buffer to process the data in a continuous manner. The result? Buffer underrun errors, which can bring recording sessions to a screeching halt. When that happens, your CD disc will be nothing more than a frisbee, ready to flip to the family dog.

PlexWriter 12/10/32A ensures a quality burn

Choose an efficient Plextor® drive, like the new PlexWriter™12/10/32A CD-rewritable E-IDE (ATAPI-4) drive, and you'll get blazing speed without creating useless CDs. Write at 12X, rewrite at 10X and read at 32X—faster than ever before.

Dramatically cut your present burn time without having to write-off bad discs as chew toys. The PlexWriter12/10/32A offers superior accuracy and reliability, easy operation, and what many can only talk about: BURN-Proof™—proven buffer underrun error protection that ensures exceptional performance and dependability, as well as providing increased productivity through multi-tasking.

Instead of flipping out, run in to your nearest Plextor dealer. For the address, call **800.886.3935**, or visit the Website at **www.plextor.com**.

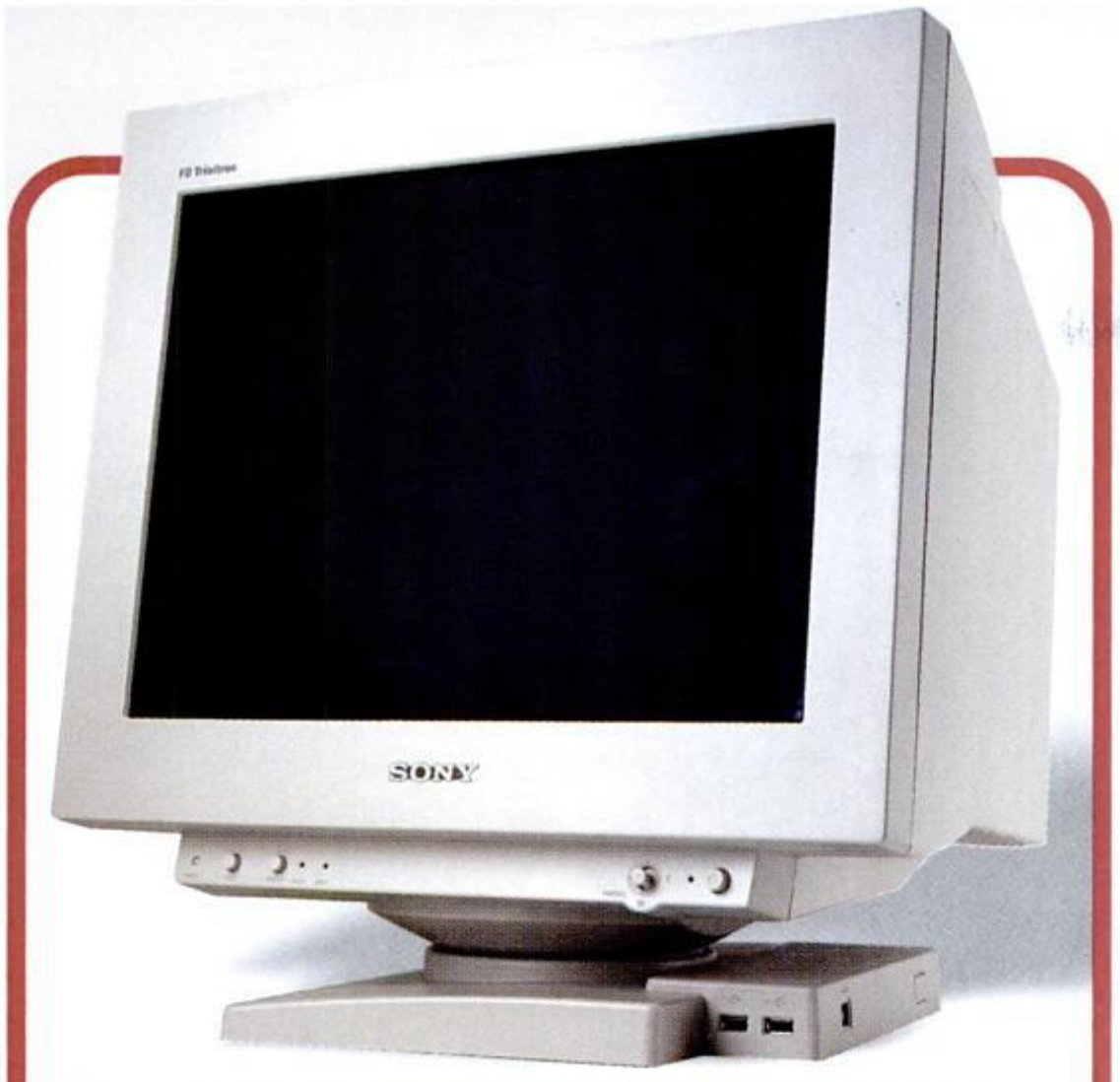
Use only the best. Plextor CD-recordable media

Recognized for Reliability

PlexWriter 8/20 May 1999 — PlexWriter 8/20 February 1999 — PlexWriter 8/20 June 1999 — PlexWriter 8/20 February 1999 — PlexWriter 8/4/32 July 2000

PLEXTOR®

©2000 PLEXTOR, Corp. Plextor is a registered trademark and PlexWriter is a trademark of PLEXTOR, Corp. BURN-Proof is a trademark of SANYO Electric Co., LTD. All rights reserved. C330.9/MaxPC



If you can muster the dough, the 21-inch Sony F500 is the best display you can put in front of your eyes. It boasts ultra-high refresh rates, true 0.22 stripe pitch, and a flat-as-a-pancake screen.

that give their displays a mottled, smudgy look.

By now, you can guess where we're going with this—we're fools for aperture grille displays! Besides looking more spectacular, AG monitors also tend to fill out the high end of each manufacturer's product line, and therefore boast better resolution, refresh rate, and pitch specs. Currently, aperture grille tubes are only manufactured by Sony and Mitsubishi, so if you find an AG monitor being sold by another company, you can rest assured that the company purchased the basic tube assembly from either Sony or Mitsubishi, then slapped on support circuitry and a plastic chassis and called it a day.

Brightness and color vibrancy aside, most *Maximum PC* editors would still prefer a 21-inch shadow mask display over a 17-inch AG display. Bigger is better, and we don't want to hear a single peep from folks who say they're sticking with their 17-inchers because larger monitors "take up too much desk space." If you need more desk space, get a bigger desk, because 19-inch monitors are entry-level in the *Maximum PC* scheme of things, and 21-inchers are standard—end of story. Not convinced? Check out the nearest 21-inch monitor, and ask yourself if you can live without the extra screen real estate. Larger monitors make for bigger browser windows, provide a more immersive gaming experience, and let you multi-task between apps without constantly rearranging your windows.

Assuming that you're going with a 19 or 21-inch monitor—and you will, oh yes, you will—be sure that your display can hit a high refresh rate at its maximum resolution, which should be 1600x1200 or greater for displays of these sizes. High refresh rates preclude the unbearable "flicker effect" that can cause eyestrain, so be sure your display can hit at least 75Hz at 1600x1200. A rate of 85Hz (and faster) at 1600x1200 is the mark of a great monitor.

The last spec you need to care about is pitch—the amount of space between neighboring screen pixels. The lower the pitch spec, the higher the detail you'll see onscreen. We'd like to tell you to go for the lowest advertised dot pitch or grille pitch possible, but some monitor companies have begun misrepresenting their products by quoting only horizontal pitch. This makes for smaller spec numbers, but doesn't fall in line with the way monitor companies have historically reported pitches. Know that the finest pitch in the consumer universe belongs to Sony, which hits 0.22mm in its high-end line. That said, be just a tad wary of spec sheets that boast horizontal pitches. While a screen's relative flatness isn't trumpeted in advertised spec sheets, this property can affect how much you enjoy your monitor. Bad shadow mask displays can be annoyingly convex, or curved on both the horizontal and vertical axes, creating a spherical effect. Most aperture grille displays also suffer from curvature, but are only curved on the horizontal axis, describing a cylinder rather than a sphere.

You can beat screen curvature altogether by upgrading to one of a new breed of monitors from Sony, Mitsubishi, and Samsung. We're talking about the Sony F400 (19-inch) and F500 (21-inch); the Mitsubishi 900u (19-inch) and 2020/2040u (21-inch); and Samsung 900IFT (19-inch) displays. These displays offer miraculously flat screens that are a joy to look at. In fact, if you're searching for the best monitor available anywhere, invest in the $1,900 Sony F500. Not only does it offer the much-sought-after flatness, it also boasts resolution, refresh, and pitch specs that are out of this world. Can you live with 1800x1440@80Hz and a 0.22mm grille pitch? Yes, you can.

Monitor Upgrades

IF YOU HAVE...	UPGRADE TO...
Shadow mask	Aperture grille
17-inch and under	19-inch and over
75Hz at highest res	85Hz (and faster) at highest res
Curved screen	Flat screen

Soundcard

It isn't a good time to be in the soundcard business. Aureal has fallen off the planet and Diamond is dropping everything to become an Internet appliance company. The only soundcard vendor we're absolutely positive will still be around in six months is Creative Labs. If you're concerned with future support for your soundcard, the only safe bet is a Sound Blaster Live! Of course, if you upgrade to the correct soundcard, you can probably skate by without tech support, so choose your new card based primarily on hardware reliability, competent drivers, and supported features.

There are five basic traits to consider in a soundcard: the number of hardware voices (3D and non-3D); the quality of the 3D sound effects; the input/output package; MIDI quality; and the software bundle. Here's the condensed version of what your new soundcard should have. The number of hardware voices is key to your listening experience. Each separate audio stream, or voice, corresponds to an individual effect in your game. When you're playing *Half-Life* and hear gunfire, footsteps, or buttons being pushed, you're hearing a separate stream for each effect. As always, more is better. At the bare minimum, you'll want 32 3D-accelerated channels, and 64 normal channels processed in hardware.

By simply adding reverb and positioning sound effects in a 3D field around your melon, a card can intensify your gaming experience. We like the Aureal-based boards for their kick-ass 3D positioning, but Sensaura-based boards, such as the Diamond MX400, are strong contenders as well. Unfortunately, the Sound Blasters leave a little to be desired in the 3D positional department, though they do excel at reverb and other environmental effects.

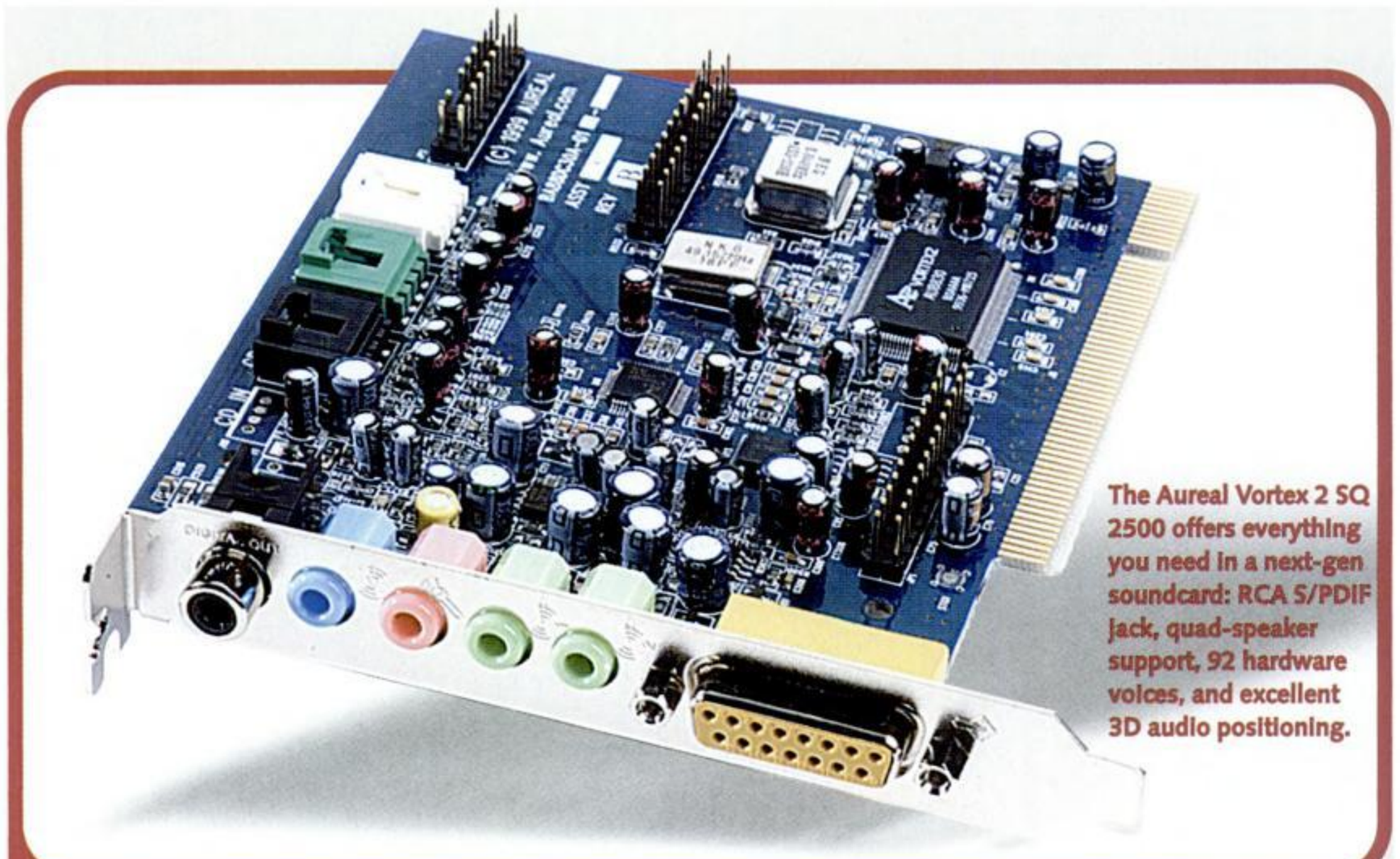
Memory

If you think upgrading to a faster CPU or videocard will net you the most speed, think again. In most cases, adding a few megabytes of RAM is more effective than installing a shiny new CPU. How much is enough? You're seriously running on empty if you're trying to push that fat Redmond OS around with 32MB or 64MB. In fact, let us know if you still have 32MB, and we'll transfer your subscription to something more your speed—like Your Grandma's PC magazine. For general use, we recommend 128MB in Win98; after that, you'll hit diminishing returns. Windows NT/2000 users should consider a minimum of 256MB; the added headroom makes editing large Photoshop files a pleasure, and keeps Windows from beating your hard drive to death as it caches applications to virtual memory.

The big question, of course, is which memory you should buy. If you're running a PC100 SDRAM box, your purchase should be PC133 SDRAM—there's really no reason to buy PC100 when the price of PC133 is virtually the same. However, PC133 SDRAM may have limited usefulness. Intel's continuing push of Direct RDRAM almost guarantees that it will become somewhat of a standard when the Pentium 4 is shipped. Very recently, Intel modulated its position to include a Pentium 4 chipset using PC133 SDRAM. This will be great for those who don't want to put out at first for Direct RDRAM, but those interested in performance should aim higher.

A dark horse you should be aware of is DDR SDRAM. Double Data Rate SDRAM will emerge this year as a serious threat to Direct RDRAM—big names such as Micron, Hyundai, and Infineon are behind it, as are AMD, VIA, along with a gaggle of folks who don't want to pay royalties to Rambus. It isn't clear who will win the battle, but it's almost certain that both RDRAM and DDR SDRAM will sink the value of PC133 SDRAM within about 12 months, so don't stock up on too much of it.

Copyrighted material



The Aureal Vortex 2 SQ 2500 offers everything you need in a next-gen soundcard: RCA S/PDIF jack, quad-speaker support, 92 hardware voices, and excellent 3D audio positioning.

Soundcard Upgrades

IF YOU HAVE...	UPGRADE TO...
Sound on your mobo	Anything. Pick a PCI card to suit your budget.
Old ISA card (SB16, 32, AWE64 or worse)	SB Live! with the bundle of your choice
Generic PCI card	Aureal Vortex 2 card, (or SB Live!-based card, if you're nervous about continued support) Aureal Vortex 1-based card
SB Live!	X-Gamer, Aureal Vortex 2, or Diamond MX400, depending on your budget
Original SB Live! or SB Live! Value	Stick with what you've got, unless you want a Live! Drive.

Be sure your next soundcard has digital outputs for home-theater or digital speakers; a pair of old-school analog outs for legacy speakers and headphones; at least one input for a mic or tape deck; and a joystick/MIDI port. If you're missing these connections, you may find yourself in a bind when you buy that second pair of speakers for full 3D positioning. The next generation of Live! cards from Creative will support 5.1 surround directly out of the back of the card. If you want the mother lode in I/O lovin', snag one of the next generation Sound Blaster Live! Platinum cards, with a front-mounted Live! Drive II I/O port interface. Supa-sweet!

MIDI used to be a big deal but, thankfully, unless you're a professional musician, that's no longer the case. Regardless, the more MIDI voices you have, the better off you'll be if you ever need them. Microsoft is hoping to revive MIDI with the next version of DirectMusic, so solid hardware MIDI support could become important next year when game developers begin using MIDI in their games.

After you've decided on the hardware, take a look at the chosen card's software bundle. Is a software DVD player included? How about audio editing utilities? An MP3 encoder? Old, crappy games? If you're going with a Creative Labs card, the answer is probably yes on all counts. The Creative Labs Live! cards are all basically identical, with specialized bundles and I/O configurations, and vastly different prices. As a general rule, first choose the hardware you want, then look to the bundle to narrow your options. You can always add software, and you can even add I/O ports on some Sound Blaster cards, but you can't add better 3D audio support.

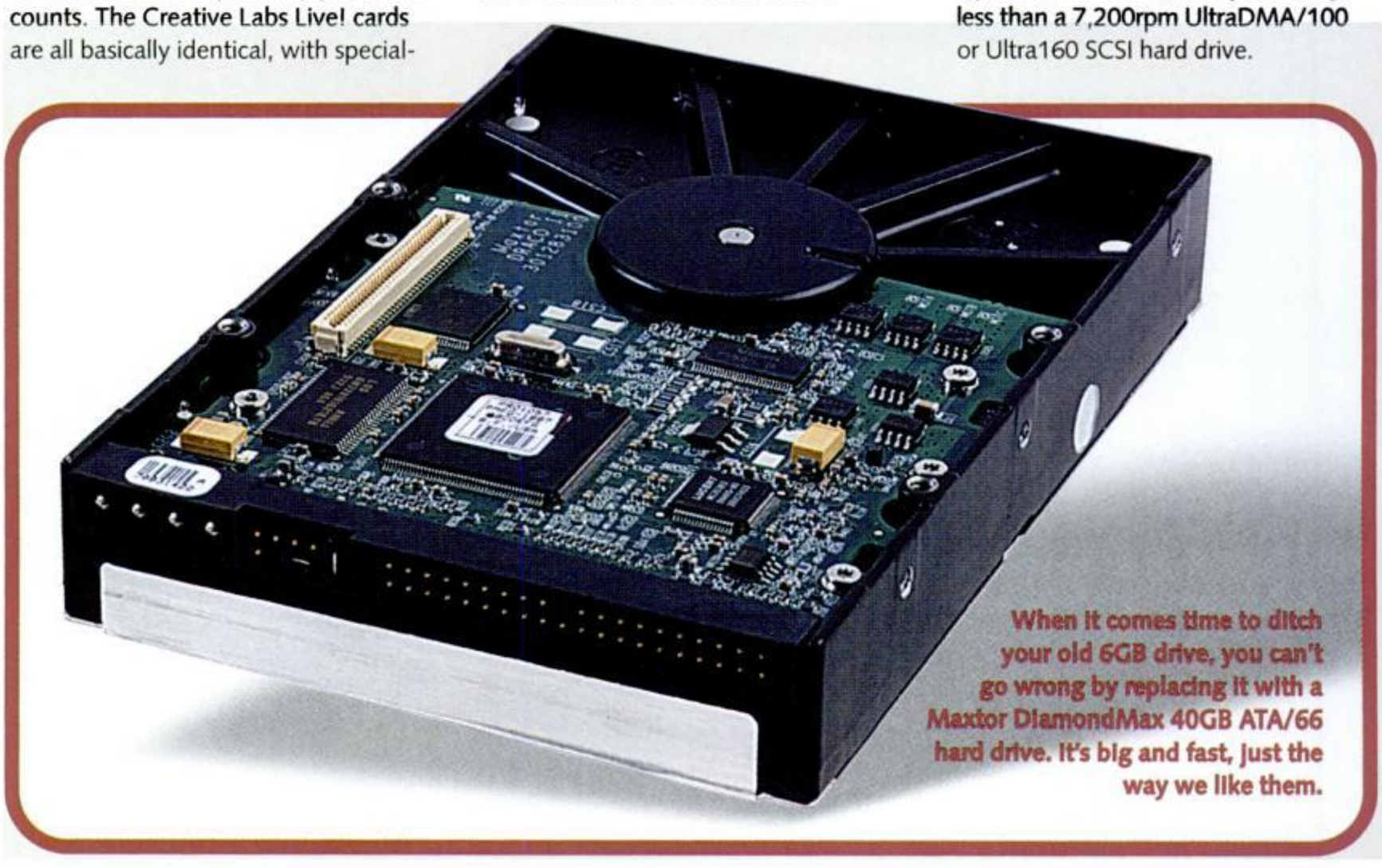
The final factor to consider is the support-to-cost ratio. Aureal is likely to be bought out this year, and Diamond hasn't been so good about supporting legacy products. Though you can find Diamond and Aureal cards for cheap, you may find yourself in driver hell six months from now. The Sound Blaster cards are the most expensive but aren't the most technically advanced, though they do have a bundle for everyone and they produce good sound. That, and you know the company will still be around six months from now.

Hard Drive

A year ago, no one expected drive manufacturers to release 40GB to 75GB consumer hard drives. But with broadband connectivity on the rise, more people are finding that the 18GB (and smaller) capacities of last year's drives are insufficient for all the movies, MP3s, game demos, and porn they're downloading. In fact, the online music craze has grown so big, hard drive manufacturers cite the storage of MP3 files as a major reason for upgrading to a larger drive. Another factor contributing to expanding drive capacities is the rising popularity of set-top boxes and personal video recorders (PVRs), such as the TiVo, which record shows directly to hard drives. Since video gobbles up gigabytes like nobody's business, the bigger the hard drive, the more functionality you get from your PVR.

Besides the increase in storage space, a new hard drive should add a little pep to your system and increase overall system performance. Of course, the fastest hard drives are also the most complex and expensive, so be prepared to sink some serious cash into your platter rattler. Older, slower drives are certainly cheaper, but we suggest you get a hard drive that uses the latest technologies, because it will contain innovations that help ensure stability, reliability, and longevity.

High-performance drives are built with the fastest spindle-speeds and highest areal densities. Typically, a performance drive will sport breakneck spindle speeds (at least 7,200rpm, and up to 15,000rpm speeds for SCSI-based drives), a larger onboard cache, and higher areal densities than the average drive. If you're shopping for a performance drive, accept nothing less than a 7,200rpm UltraDMA/100 or Ultra160 SCSI hard drive.



When it comes time to ditch your old 6GB drive, you can't go wrong by replacing it with a Maxtor DiamondMax 40GB ATA/66 hard drive. It's big and fast, just the way we like them.

Copyrighted material

DVD or CD-R? If you want both, try a combo DVD/CD-R drive, such as Samsung's SM-304B or Toshiba's SD-R1002. They're a little slow, but they're extremely versatile.

Of course, you don't need 15,000rpms if you're only interested in packing away more downloads. It may be wiser to purchase a larger, non-performance drive with greater storage capacity as a companion to a fast primary drive, especially if you're happy with the way your primary drive runs. Though targeted toward low-end machines, value drives add a lot of cheap storage space for large files and MP3 collections; they're normally larger than performance drives by around 5GB to 10GB. While the overall average throughput of a value drive is typically 8 to 10MB/sec slower than high-performance drives (which currently range from 25 to 30MB/sec), they're still fast enough to stream most audio and video content.

Should your next hard drive be SCSI? If you want the fastest thing out there, go SCSI, but get ready to pony up some hefty ducats. SCSI drives are pricey because they contain expensive monitoring chips and run at speeds up to 15,000rpm. SCSI drives also require a high-end SCSI host adapter that plugs into a PCI slot, which drives the price even higher. High-end SCSI drives typically go for between $300 and $1,000, depending on the spindle speed, drive size, and connection technology used. Typically, the home enthusiast can get by with an Ultra2 SCSI-based drive, although Ultra160 is the fastest flavor available. Ultra2 doubles the total bus throughput of Ultra Wide SCSI to 80MB/sec by increasing the clock rate to 40MHz, while Ultra160 doubles that rate again to 160MB/sec. Since a single SCSI-based drive has a typical transfer rate of only 30 to 40MB/sec, you can see why Ultra2 does just fine. Of course, the newer Ultra160 drives contain new technologies and higher areal densities, and thus offer higher performance, which is a good reason to consider the latest and greatest.

The current ATA standard is UltraDMA/100, which recently replaced UDMA/66. UDMA/66 doubles the previous total bus bandwidth of UDMA/33 to 66MB/sec, and UDMA/100 takes this to—you guessed it—100MB/sec. If you purchased your machine before Christmas of 1999, you're likely stuck with UDMA/33 support, but you can add a UDMA/66 controller, such as the Promise Ultra66, if you want to upgrade to a supa-fast hard drive. UDMA/66 drives work with UDMA/33-based controllers, but you'll lose those 66MB/sec burst speeds. Promise also makes a UDMA/100 controller, allowing those of you with a new UDMA/100 and an older UDMA/66 motherboard to realize your drive's full potential.

Hard Drive Upgrades

IF YOU HAVE...	UPGRADE TO...
No space on an older PC that supports older ATA drives	30GB ATA drive running at 5,400rpm
No space on an older UDMA/33 drive 5,400rpm	30GB UDMA drive, or a Promise Ultra66 controller and a 30GB UDMA/66 drive running at 5,400 or 7,200rpm
Slow hard drive, and need the fastest IDE performance available	Promise Fastrak RAID controller and two 20GB UDMA/100 7,200rpm drives
Slow hard drive, and need the kind of speed that only SCSI offers	Ultra160 SCSI controller and a 10,000rpm 18GB Ultra2 SCSI hard drive
Space and need the extreme speeds offered only by high-end SCSI	Ultra160 SCSI controller and a 10,000rpm 36GB Ultra160 SCSI hard drive
Desire to spend a lot of money on the ultimate in hard drive performance and capacity	Ultra160 SCSI RAID controller and two 15,000rpm 18GB Ultra160 SCSI hard drives

CD/DVD

In *Maximum PC*'s January 2000 "Millennium Survival Guide" feature, we predicted that 2000 would be the year CD-RW dominated desktops, and we're still singing that song. DVD has failed to garner anything more than an enthusiast following—besides, who likes to watch movies sitting at the computer? On the flipside, using a plain-old CD-ROM drive is so 1998. Right between these two "limited purpose" extremes lies the CD-RW drive, which can read CDs, burn CDs, and extract audio from your CD collection faster and more reliably than most DVD and CD-ROM drives could ever hope to.

So which CD-RW is the best? The answer depends on whether you go SCSI or IDE. SCSI drives are immensely better for CD duplication. Compared to IDE's single-threaded I/O interface, which executes just one I/O request at a time, the SCSI bus is built to handle up to 256 simultaneous threads of data. SCSI's more robust I/O interface, combined with its lower CPU overhead, provides CD-RWs with smoother data transfers than IDE can offer. When burning a CD, you don't want anything sharing the resources dedicated to keeping the burner's cache full, so the fewer distractions the drive has, the better your chances of not burning a coaster. IDE users usually tiptoe around their PCs when burning CDs, out of fear that they'll cause a buffer underrun. SCSI users, however, can play a game, surf the net, or even launch a DoS attack while burning a CD.

The fastest SCSI drives now record at 12x, but many CD connoisseurs are content to record at slower speeds for consistency's sake, so an 8x or 6x drive will suffice. For IDE users, the fastest speed on the market is 12x record, 10x rewrite, and 32x read. IDE drives can record as quickly as SCSI drives of similar specification, but suffer from residence in the IDE chain, and the drives require excessive CPU resources to function properly. Most IDE users should be content with a slower drive until 12x burners drop in price.

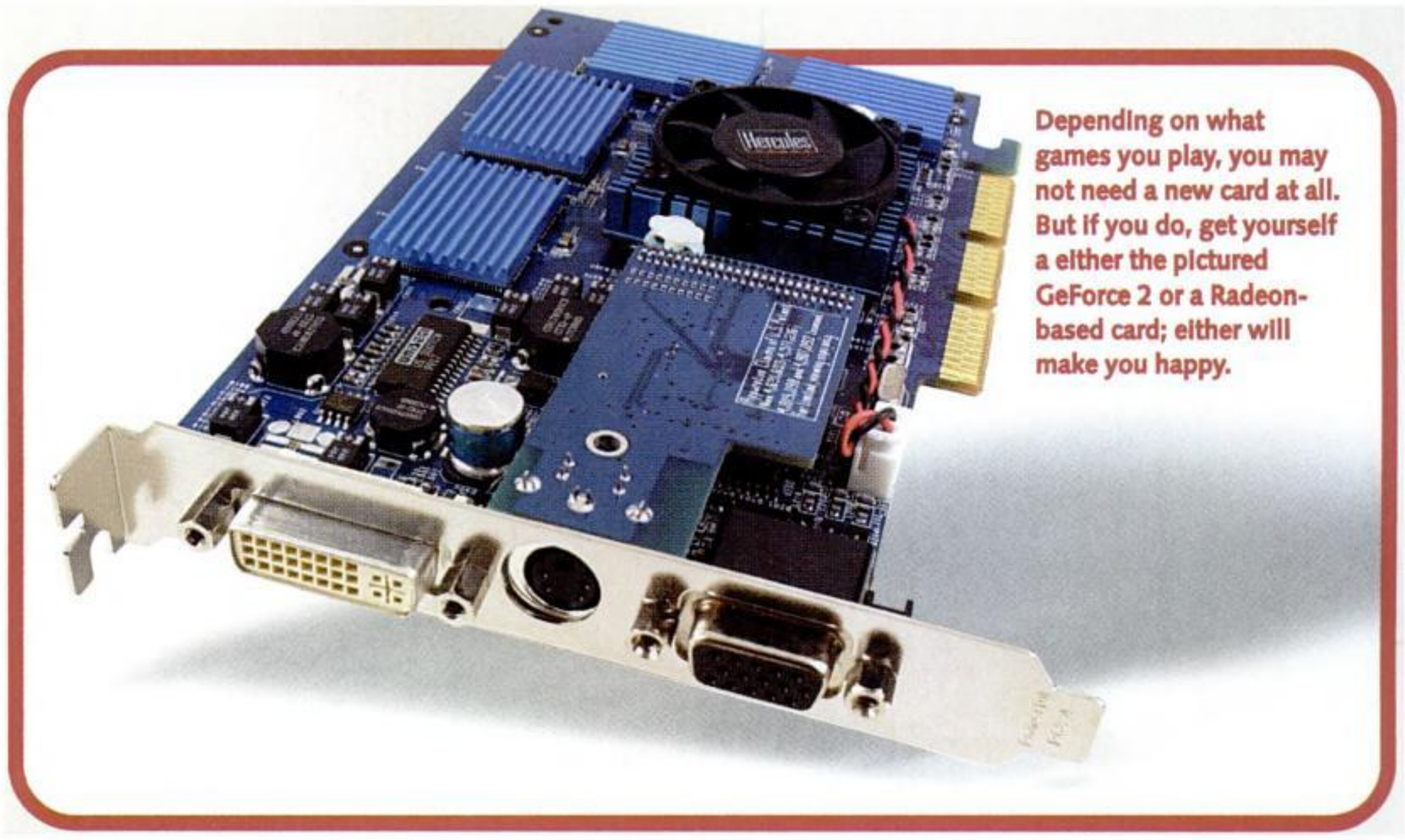
You also you need to decide whether you're going to use your CD-RW for evil—that is, audio extraction or copying games. If you want to make copies of games, you need a drive that does bit-for-bit accurate copying. This allows the drive to record bad sectors that have been purposely placed on a disc to foil CD duplication programs. It also lets you create exact copies of all games. For audio extraction, a crappy drive will record songs with hisses and pops, and will typically do so at a slow pace. Good drives will correct errors automatically, or won't suffer errors in the first place, thanks to alignment technology built into the drive for increased accuracy in extraction and quick, high-quality audio work.

CD/DVD Upgrades

IF YOU HAVE...	UPGRADE TO...
DVD-ROM	At least a 6x/4x/24x CD-RW
CD-ROM	At least an 8x/4x/32x for CD duplication
4x IDE CD-RW	12x/10x/32x drive
6x SCSI CD-RW	If you're the impatient type, upgrade to a 12x recorder. Just think—six minutes to fill an entire disc.

Copyrighted material

Videocard



Depending on what games you play, you may not need a new card at all. But if you do, get yourself a either the pictured GeForce 2 or a Radeon-based card; either will make you happy.

New graphics processors are being introduced with increasing frequency, so it's getting more and more difficult to stay on the cutting edge of 3D. Just when videocards based on the latest and greatest 3D chipset arrive in stores, another chipset, with new features that promise to rock your world, is announced. But, while nothing seems to suck more than buying a top-of-the-line GeForce 2 GTS board just in time to hear the GeForce 2 Ultra announced, don't despair. The truth is, you may not even need a GeForce 2.

To determine your true 3D hardware requirements, look to the games you play. Don't bury your head in the sand and pretend that features such as full-scene anti-aliasing and hardware transform and lighting are unimportant, but do consider the fact that they might not be important to you right now. How much innovation do you really need if all you play are 2D realtime strategy games and *Diablo* clones?

On the other hand, first-person shooter fans need single-cycle multitexturing, geometry acceleration, and ultra-high fill rates. And if you're a flight sim freak, the FSAA features on such videocards as 3dfx's Voodoo5 will definitely improve your flying experience.

The base capabilities you should look for in a videocard are 32-bit color rendering, single-cycle multitexturing, and fill rates that hit at least 350 megapixels per second. Without decent fill rates and support for single-cycle multitexturing, all the visual treats in games such as *Heavy Metal F.A.K.K. 2* will bog down your frame rates. Current games are designed with multiple 32-bit textures used as bump maps, light maps, and detail maps. More textures are being applied to a single pixel, so 16-bit color just won't cut it anymore—the dithering artifacts, color banding, and crappy-looking alpha blends will ruin your gaming experience. True color-rendering shows your 3D in the best light possible, so be sure your hardware does it and does it well.

The rapid production of 3D chipsets puts a lot of innovation in your corner, but the key is to keep an eye on what features are important. New 3D chips launch every six to eight months, and chipmakers each tout the features that set their offering apart from the crowd. Last year, S3 talked up its texture compression, Matrox bragged about its bump mapping, and nVidia asserted the advantages of its hardware T&L. Don't worry if your next card doesn't support DirectX 8.0 pixel shaders, for instance, because no game will use them until next year. As important as hardware transform and lighting support is in the grand scheme of 3D acceleration, it doesn't mean squat when there aren't any games available to take advantage of it. By the time hardware T & L pixel-shader games are stocking store shelves, brand-spankin' new videocards will run circles around the current generation of hardware.

Chipmakers such as nVidia keep an aggressive schedule so they can stay in step with the hardware refresh cycles of the major OEMs. If you have pockets as deep as Dell and Micron, then by all means, continue to buy the latest and greatest.

If you don't need the advanced features, just sit tight on the hardware that you have. At some point, you'll buy a game that brings your GeForce to its knees. When that happens, buy the fastest thing out there and hope it doesn't become obsolete before the year is out.

Videocard Upgrades

IF YOU HAVE...	UPGRADE TO...
Graphics chip integrated into your motherboard	A Voodoo5 5500 PCI or GeForce2 MX
Savage3D, Permedia3, PowerVR Series 2, Savage4, i740	Anything is better than what you have now. If you want something to tide you over until the big guns are released in 2001, pick up a GeForce DDR board.
TNT2 Ultra, Voodoo2 SLI, G200, Voodoo3	It's time to move on to a more capable videocard. Any board based on GeForce 2 GTS or Radeon 256 should keep your pixels pumping for another year or so.
Millenium G400, Rage 128, Savage 2000, GeForce, Voodoo5	If you can't stand any slowdown in your games, upgrade to a GeForce 2 Ultra. Otherwise, just grin and bear it for six months, and upgrade to something truly revolutionary.
GeForce 2 GTS	You're sitting pretty. Wait until nVidia's NV20 and 3dfx's Rampage arrive in 2001.

Future Prophecies

If you think computing can go only so far and no further, think again. We'll see speed advances this year that'll put your PC to shame. By the end of the year, Intel is promising to begin shipping Pentium 4 at 1.5GHz. Intel has already demonstrated the CPU at 2GHz, and we're willing to bet that the P4 makes it all the way to 10GHz by 2005. The P4 features a 400MHz system bus and math units flying along at twice the core speed. Cache size is still unknown.

Intel's real secret weapon, however, may be in the Willamette New Instructions (WNI). Like the MMX and Katmai New Instructions of yore, these 72 new commands allow the CPU to take shortcuts in complex operations, speeding up 3D graphics and multimedia. Since Intel is the dominant force in PC computing, almost all software developers are likely to compile for Pentium 4, thus making any new program faster.

In the next year, we'll also see Intel's first 64-bit CPU, the Itanium. While consumers don't yet need 64-bit computing, those who need to juggle terabytes of data in RAM will get a shot in the arm; it's expected that an Itanium-based server running quad CPUs and, say, eight terabytes of RAM can replace a row of older machines and offer faster performance, because entire databases can remain resident in RAM instead of living on infinitely slower hard drives.

PC I/O devices are about to receive a major enema as well. By early 2001, most PCs will come equipped with USB 2.0, Serial ATA, and DVI connectors. The ISA bus will finally die the horrible death it so deserves.

This past year marks the first time AMD posed a serious threat to Intel's dominance. After it was introduced, the Athlon ran ramshackle for months over Intel's best, and AMD's Thunderbird Athlon again put Intel on the defensive. AMD has continued to lead the clock speed race and says it expects to be the leader due to its use of copper interconnects. Intel isn't expected to get to a copper interconnect process until 2001.

AMD also has plans to take on Itanium with its Sledgehammer CPU. The "Hammer" will add 64-bit extensions to the 32-bit x86 instruction set. AMD says that while 64-bit is obviously intended for servers and high-end workstations, there are plans to integrate 64-bit extensions into every AMD CPU. Perhaps someday, we'll even have software that takes advantage of all these hardware advances. Dare to dream.

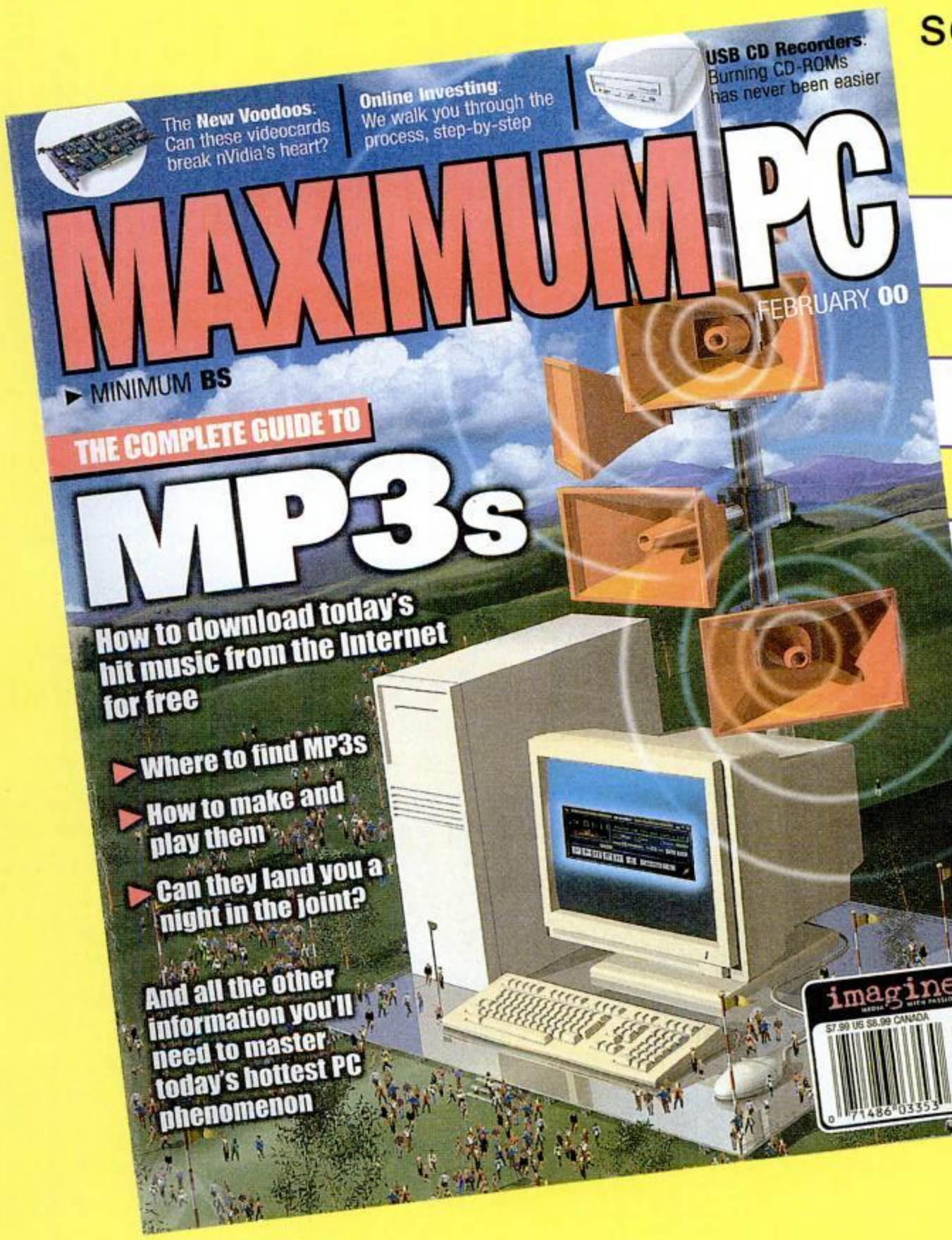
Copyrighted material

F R E E

MAXIMUM PC

Try it today!

Get the final word on the latest hardware, software, games, and gear.


The New Voodoos: Can these videocards break nVidia's heart?
Online Investing: We walk you through the process, step-by-step
USB CD Recorders: Burning CD-ROMs has never been easier
MAXIMUM PC
FEBRUARY 00
MINIMUM BS
THE COMPLETE GUIDE TO
MP3s
How to download today's hit music from the Internet for free
Where to find MP3s
How to make and play them
Can they land you a night in the joint?
And all the other information you'll need to master today's hottest PC phenomenon
imagine
57.99 US $8.99 CANADA
02>
0 71486 03353 0

TIPS

ADVICE

REVIEWS

HOW-TO's

and more!

Mail the attached card now!

Copyrighted material

Faster Internet Connections

Everyone wants more speed from their Internet connection. The one-step setup programs provided by ISPs insulate users from advanced settings to prevent incompatibilities and save on support time, but they rob you of performance-enhancing options that may speed up your connection. Before you get your hands dirty optimizing your connection, sit down and establish a baseline by downloading identical files from several different ftp sites. You can also use sites such as dslreports.com to get a good baseline reading. Once you know your current connection speed, follow the guidelines and recommendations below to bring it to the next level. Take back the bandwidth that's yours; after all, you paid for it. *—Fabian Echevarria*

STEP 1 Choosing your modem

First, choose a modem that'll serve your needs. External or internal doesn't matter, since the speed difference is negligible. External modems are generally a better bet if you're willing to pay for them, since they don't tie up a slot, use an IRQ, or have the same kind of Plug and Play issues that internal modems do. The true distinction lies between corporate and consumer modems. In general, corporate modems are designed for mission-critical applications, whereas consumer modems are designed with less lofty (and more price-cutting) goals in mind. As such, corporate modems are more robust when it comes to capability and stability.

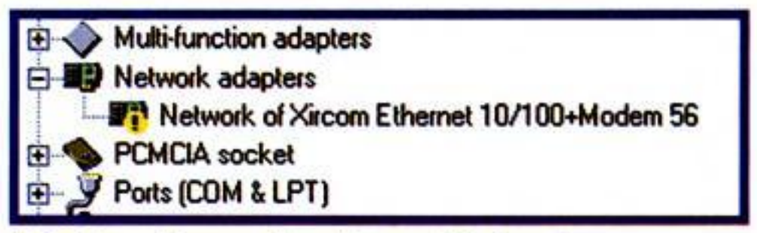
Since your ISP's equipment is probably corporate-quality (U.S. Robotics Total Control rackmount modems, Ascend modem pools, etc.), you'll get more performance when using a similar modem. Until recently, the price difference was prohibitive, but still worth it. For most people, though, a good-quality name-brand modem should be fine. Stay away from controllerless modems, since the command interpretation and control functions (including error correction and data compression) on these POSs are handled by your CPU. They're cheap, but best left for web browsing. Controllerless WinModems use incredible amounts of CPU time, so CPU-intensive operations (such as online gaming and streaming audio/video) bring controllerless modems to their knees. Almost all PCI-based modems are controllerless, and using one is a waste of a PCI slot, because even the fastest PCI modem will never touch 133MBps.

STEP 2 Connecting your modem

Line conditions can be improved with high-quality cable, such as the Category 5 patch cable used in high-end networking. Using CAT-5 to connect your modem to the wall jack can make a difference, especially if the rest of the house is wired with equally good cable. Homeowners might consider running it directly to the phone company's breakout box. If you do any re-wiring, be sure that your modem cable is routed away from power lines, speakers, and other sources of electrical noise. Also, be sure to connect external modems to your machine using a properly shielded serial or USB cable.

STEP 3 Resolve all hardware conflicts

Resource conflicts can greatly hamper connection stability. Use your BIOS and Windows Device Manager (located in the System control panel) to seek them out—you'll know there's a conflict because of the yellow exclamation point (Figure 3.1) next to an offending resource. Pay special attention to any that appear next to your serial port. If you find one, enter its Properties and look under the Resources tab for an explanation. It's usually caused by a memory address or interrupt resource being used by another device. Often, manually changing the resource to an unused value will fix the problem. Also, try changing the resource of the conflicting device (it should be listed). If you can't, consult your manual or the manufacturer's web site. Unfortunately, there's no simple conflict resolution advice that works all the time. Sometimes, the only recourse is to remove the offending device entirely. Fortunately, Win98 does a pretty good job of configuring things automatically.



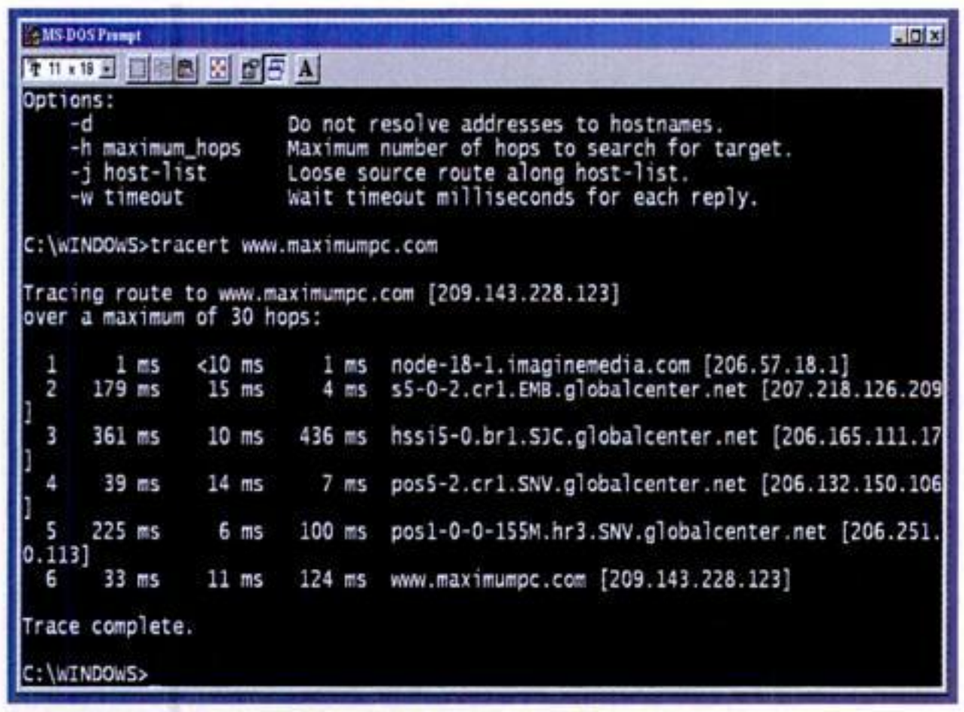
3.1: The yellow exclamation point denotes a system-resource conflict.

STEP 4 Choose your ISP carefully

All ISPs are not created equal. Ask several ISPs for bandwidth info and total number of dial-up ports available. Be sure they support your modem's highest speed, and match your modem's chipset with theirs. Most ISPs have guest accounts you can use for an evening or two for testing. Connect several times and use TRACERT, which comes with Windows, to look for slowdowns at your favorite destinations. For instructions, type TRACERT at a DOS-prompt (see Figure 4.1). Keep in mind that TRACERT doesn't test speed—it tests latency. This is important, since small mom and pop ISPs are often only on a single national backbone, so smaller sites located on a different backbone might be several hops away. Large ISPs are connected to many backbones, so latency is less of an issue. Of course, large ISPs often aren't as finely tuned as a small ISP. It's a good idea to talk to your potential ISP, and ask to try out their dial-ins.

TRACERT sends a packet of info to each "hop" or node between you and your

Copyrighted material


MS-DOS Prompt
Options:
-d Do not resolve addresses to hostnames.
-h maximum_hops Maximum number of hops to search for target.
-j host-list Loose source route along host-list.
-w timeout Wait timeout milliseconds for each reply.
C:\WINDOWS>tracert www.maximumpc.com
Tracing route to www.maximumpc.com [209.143.228.123]
over a maximum of 30 hops:
1 1 ms <10 ms 1 ms node-18-1.imaginemedia.com [206.57.18.1]
2 179 ms 15 ms 4 ms s5-0-2.cr1.EMB.globalcenter.net [207.218.126.209]
3 361 ms 10 ms 436 ms hssi5-0.br1.SJC.globalcenter.net [206.165.111.17]
4 39 ms 14 ms 7 ms pos5-2.cr1.SNV.globalcenter.net [206.132.150.106]
5 225 ms 6 ms 100 ms pos1-0-0-155M.hr3.SNV.globalcenter.net [206.251.0.113]
6 33 ms 11 ms 124 ms www.maximumpc.com [209.143.228.123]
Trace complete.
C:\WINDOWS>

4.1: TRACERT shows the number of hops to your favorite web site and how long it'll take to get there.

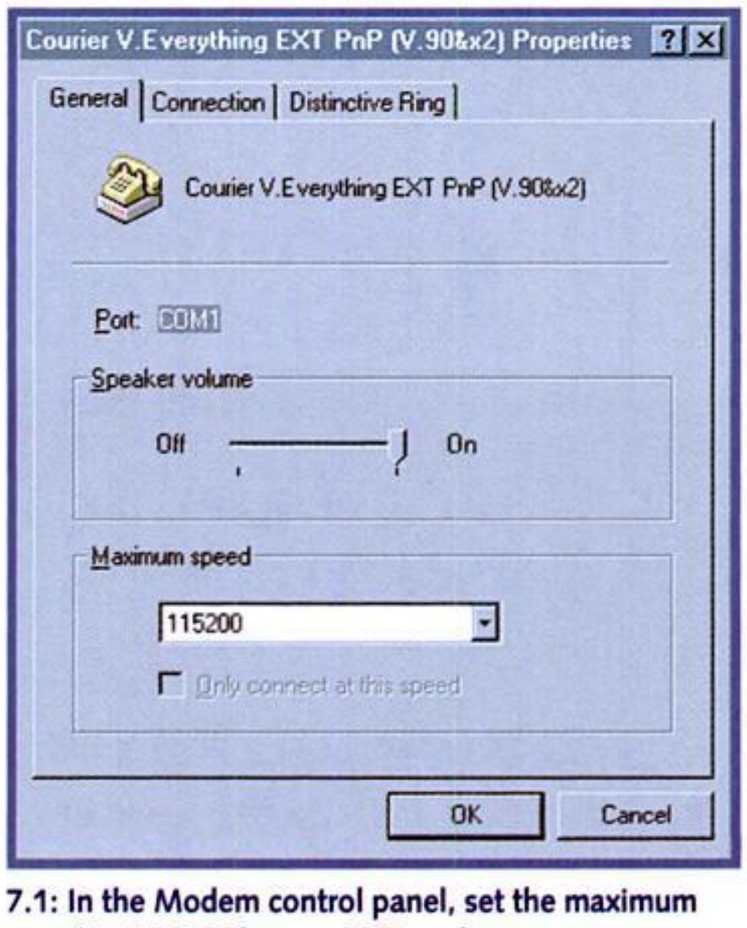
destination. It measures responses from each hop three different times (don't add them all up), listing them in milliseconds. This tells you the total hops between you and your destination and what kind of response you're likely to expect. Of course, the fewer hops, the better. Response times below 100ms on a broadband connection are considered good; on a 56k modem, 200ms is acceptable, up to 400ms is marginal, and anything higher is lousy. Ping time (not raw line speed) is the most important thing to online gaming. "Low ping bastards" have a huge advantage against a player on a high ping link. You should test the ping rate of the game servers where you hang out on a regular basis.

STEP 5 Update Windows

Microsoft has released a bunch of updates that improve the performance of your Internet connection under Windows 95. The two with the most connection-improving power are Dial-Up Networking 1.3 and Winsock 2.2. Even seemingly unrelated OS improvements can correct memory leaks and other problems in the TCP/IP stack or other components, so be sure to patch up your OS with all the latest updates. You can find these upgrades in the support area of Microsoft's web site. Don't worry about these upgrades if you're running Win98 or Win2000, since Microsoft has included them as standard components.

STEP 6 Update your modem drivers

Unless Windows knows how to handle your modem properly, the Modem control panel options may not work correctly. Users of the original retail version of Windows (4.00.950) should install the UniModem (a.k.a. voice modem) drivers released by Microsoft before proceeding any further. Windows OSR2 (4.00.950 B or C) and Windows 98 users can skip the UniModem installation, since it's included in those versions. In any case, obtain the latest modem driver from your modem's manufacturer (**windrivers.com** is also a great resource). Usually the generic modem driver built into Windows works fine, but it's always good to install the driver from your modem manufacturer.



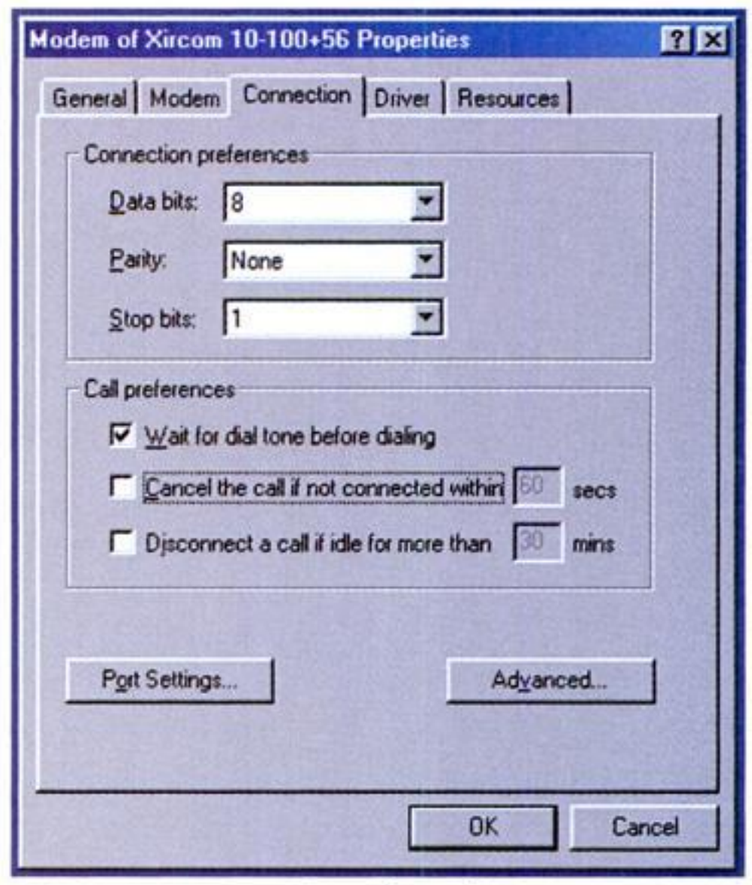
7.1: In the Modem control panel, set the maximum speed to 115200 for your 56K modem.

STEP 7 Optimize your modem and serial port

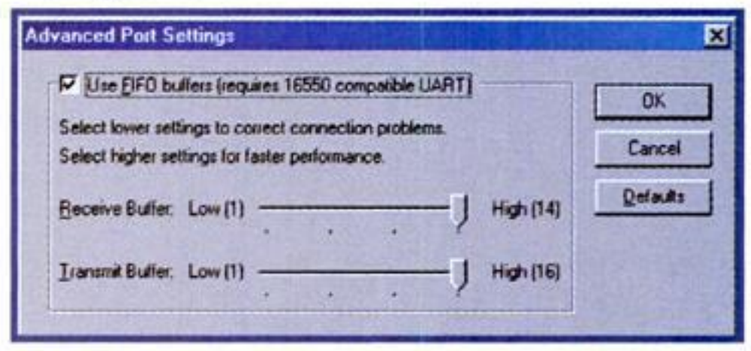
Modems use two different speeds: computer-to-modem speed (DTE) and the speed between your modem and your ISP's modem (DCE). DCE is your line speed, and it's typically 53kbps. For optimal performance, DTE speed should be set faster than DCE speed to give your modem time to buffer data and, if possible, compress it.

Of course, Windows defaults to archaic settings no matter what speed your modem and serial port are capable of attaining. To straighten this out, venture into the Modem control panel and change the maximum speed field to 115200. Be sure to disable the "Only connect at this speed" box (shown in Figure 7.1), and confirm that the "Data bits," "Parity," and "Stop bits" fields are properly set for your ISP (default settings are shown in Figure 7.2).

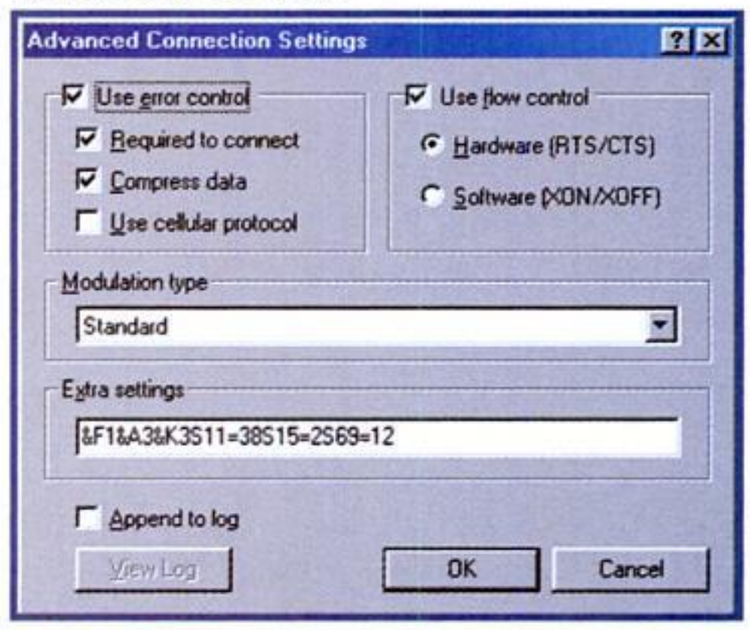
Under the Advanced Port Settings, enable the FIFO buffers and move the Receive and Send buffer sliders to their maximum values (14 and 16, respectively—see figure 7.3). This allows your serial port to properly buffer incoming and outgoing data while reducing CPU overhead. Use the settings shjown in Figure 7.4. Under the Advanced option of the Connection settings, put an initialization string in the Extra Settings field that allows your modem to perform up to its maximum capability and match the options you just set.



7.2: Be sure your parity and stop bits match your ISP's.


Advanced Port Settings
Use FIFO buffers (requires 16550 compatible UART)
Select lower settings to correct connection problems.
Select higher settings for faster performance.
Receive Buffer: Low (1) High (14)
Transmit Buffer: Low (1) High (16)
OK
Cancel
Defaults

7.3: Crank the receive and send buffers to maximum and enable FIFO buffers.



7.4: Customized settings such as v.42bis over MNP5 may help your speed.

Consult your modem's manual and/or manufacturer for specific commands when creating your initialization string. Your string should enable hardware handshaking (specifically RTS/CTS), but disable retrains and MNP 5. Both MNP 5 and v.42bis compress data; however, v.42bis is 30 percent faster and does not add latency to the data stream. MNP 5, an older compression scheme, can add latency. Disabling retrains prevents long time-outs due to total-line renegotiations (instant death in the middle of a deathmatch). Just leave upshifts/downshifts enabled so your modem can adjust to adverse line conditions on the fly without full-line renegotiation.

STEP 8 Optimize dial-up networking

Windows takes a shotgun approach to network settings by assuming everyone

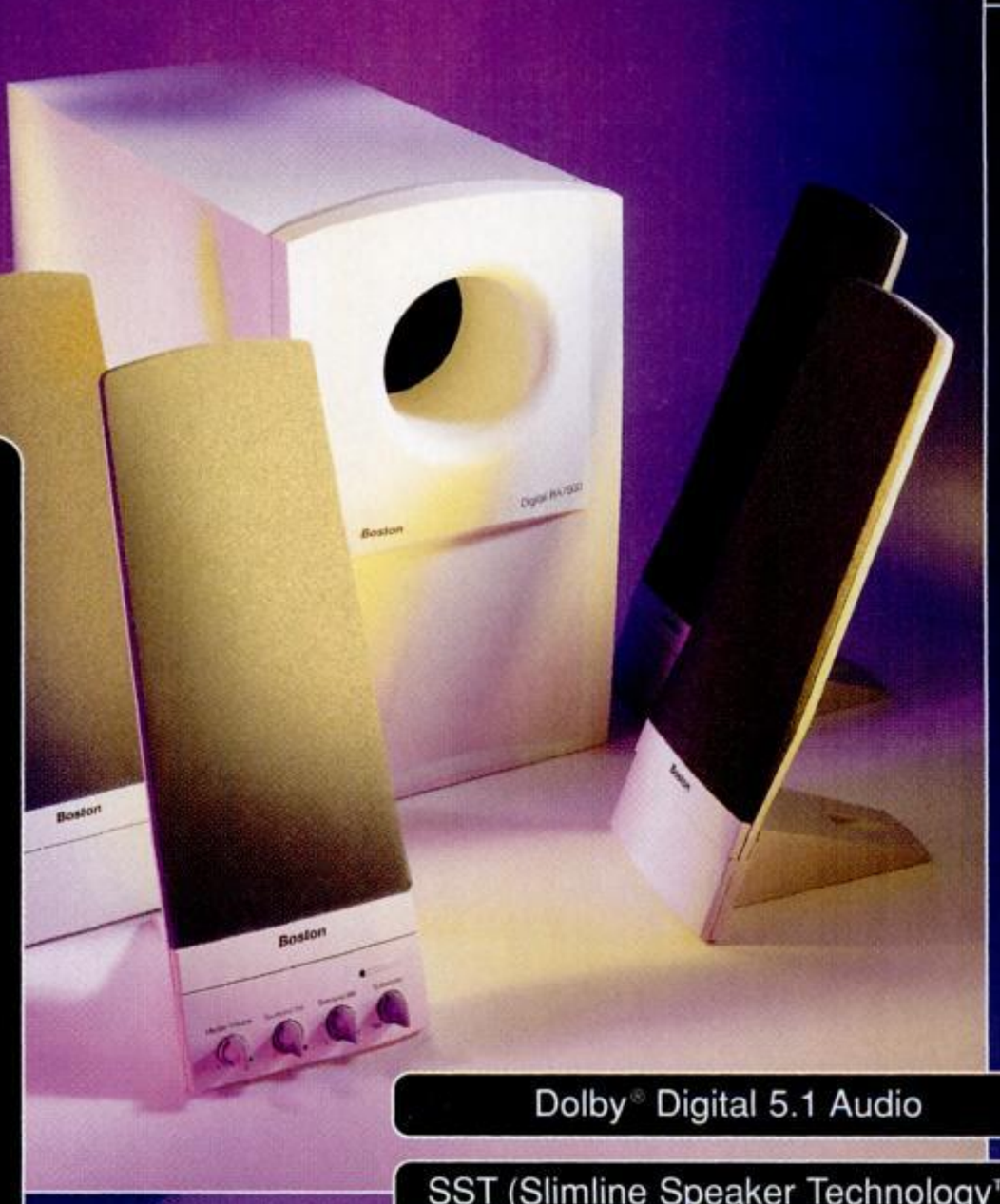
Copyrighted material

Boston

HOME CAR MULTIMEDIA CUSTOM

DOLBY DIGITAL

ITS FATHER WAS A $5,000 HOME THEATER SPEAKER. ITS MOTHER WAS A SUPERMODEL.



It sounds incredible. It's packed with technology. And it's thin enough to appear on the runways of Paris and Milan. Boston Acoustics introduces the first multimedia system using SST™ satellites. The result: dynamic, full-range, high-fidelity sound from a satellite that's less than three centimeters thick. The Digital BA7500™, with Dolby® Digital, SST, and 4-channel compatibility, gives the PC gamer a big shot of audio adrenaline. Just what you'd expect from Boston Acoustics, a company with over two decades of loudspeaker expertise. To learn more about the Digital BA7500, visit www.bostonacoustics.com. Its parents would be so proud.

- Dolby® Digital 5.1 Audio
- SST (Slimline Speaker Technology™)
- 4-Channel PC Gaming

Buy Now

www.bostonacoustics.com

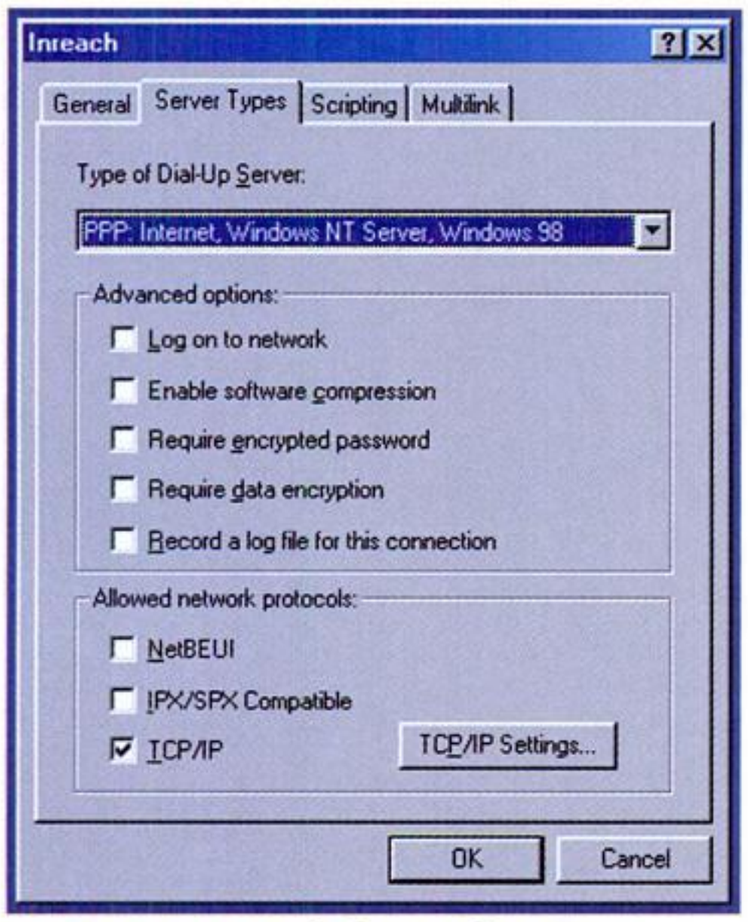
Also available at most electronics and home computing stores.

For a complete Boston Multimedia story, visit www.bostonacoustics.com or order now toll-free, 1-877-333-4001.

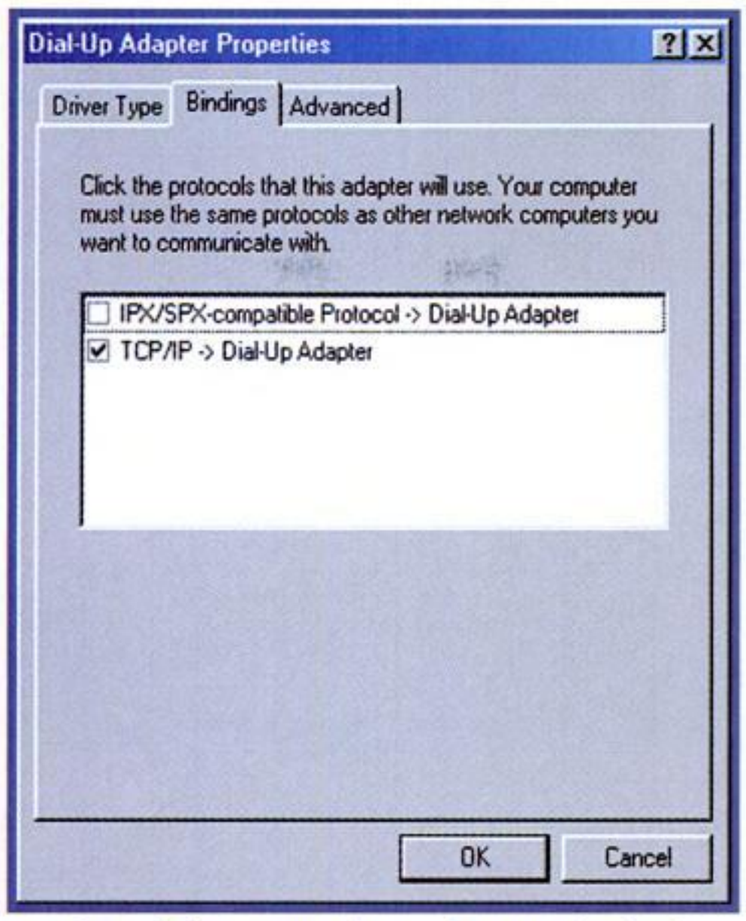
© 2000 Boston Acoustics, Inc. All rights reserved. Digital BA7500, Slimline Speaker Technology, and SST are trademarks, and Boston Acoustics and Boston are registered trademarks of Boston Acoustics, Inc. Dolby Digital is a registered trademark of Dolby Laboratories.

Boston

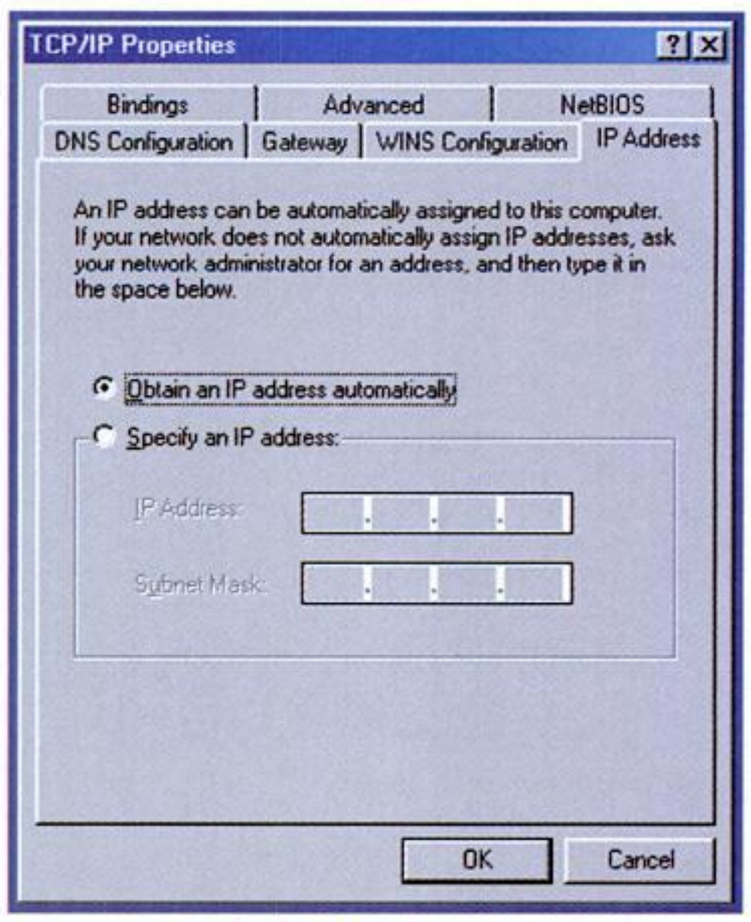
Copyrighted Material



8.1: Too many protocols slow your login time. TCP/IP should be enough.


Dial-Up Adapter Properties
Driver Type
Bindings
Advanced
Click the protocols that this adapter will use. Your computer must use the same protocols as other network computers you want to communicate with.
IPX/SPX-compatible Protocol -> Dial-Up Adapter
TCP/IP -> Dial-Up Adapter
OK
Cancel

9.1: If you dial up, you only need TCP/IP checked. Shed extraneous stuff like IPX/SPX.


TCP/IP Properties
Bindings
Advanced
NetBIOS
DNS Configuration
Gateway
WINS Configuration
IP Address
An IP address can be automatically assigned to this computer. If your network does not automatically assign IP addresses, ask your network administrator for an address, and then type it in the space below.
Obtain an IP address automatically
Specify an IP address:
IP Address:
Subnet Mask:
OK
Cancel

9.3: Your ISP probably assigns an IP to you when you log in. Make sure settings match that.

connects to Windows NT hosts, not ISPs. You can correct this oversight and simplify the logon process at the same time. In the Dial-Up Networking folder, select the properties for your Internet connection. Change the settings to match those shown in Figure 8.1. Your logon speed will be greatly improved because Windows will stop trying to log on to a network host and to your ISP. Deselecting software compression allows your modem to handle all compression in hardware, saving CPU cycles and system resources for more important tasks.

If you've installed Dial-Up Networking (DUN) 1.3 or use Windows 98, two additional options ("Require encrypted password" and "Require data encryption") appear under the Server Types tab of the Dial-Up Networking Properties. Leave them at the default settings (unmarked); enabling them needlessly ties up system resources. If, after installing DUN 1.3, additional options don't appear, you'll need to remove and reinstall the Dial-Up Adapter (keep newer files during the reinstall process, if notified of any). Reinstalling will return things to normal if something goes wrong.

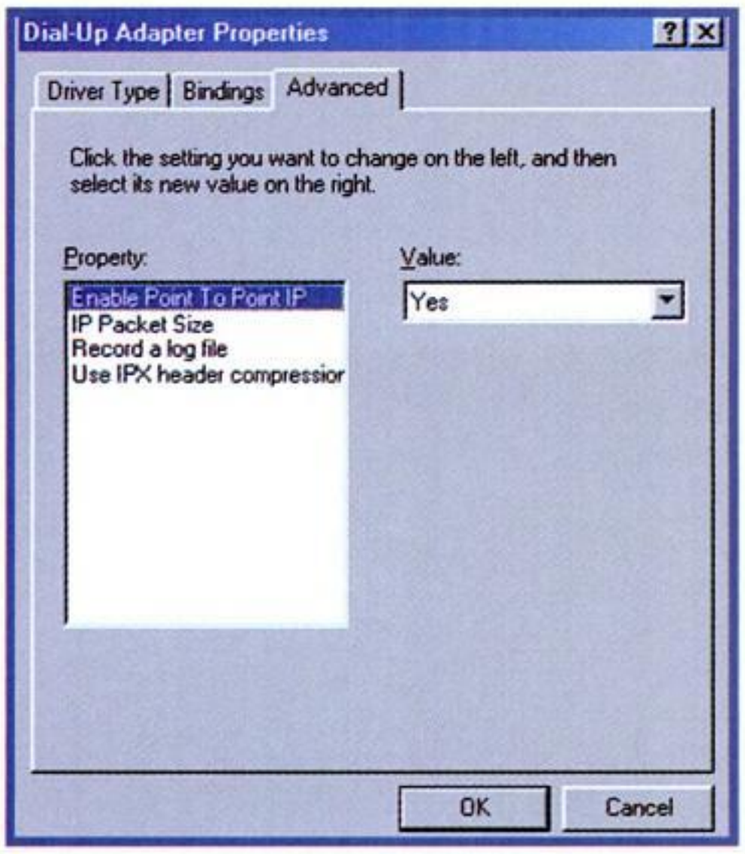
Under TCP/IP Settings, select "Use default gateway on the remote network." If your ISP allows automatic IP addressing and DNS determination, mark "Server assigned IP address" and "Server assigned name server address." But if your ISP requires a specific IP address or DNS setting, select "Specify an IP address" or "Specify name server addresses" and complete as required by your ISP.

STEP 9 Optimize your network settings

You only need Dial-Up Adapter and the TCP/IP protocol to connect to the Internet. If you don't use other protocols, adapters, or services, remove them using the Network control panel. Removing individual network components via the Network control panel doesn't harm your system or the new components as long as you keep newer files when notified. If only Dial-Up Adapter and the TCP/IP protocol are installed, subsequent visits to the Network control panel will cause Windows 98 to display the error message "Your network is incomplete." To avoid this error message, you can leave the Microsoft Family Logon installed.

In the Network control panel, select the Dial-Up Adapter properties. Under the "Bindings" tab, select TCP/IP and deselect everything else (see Figure 9.1).

Under the Advanced tab, set the "Record a log file" property to No, or you'll needlessly slow down your connection. If you use Windows 98, two additional options appear in the Dial-Up Adapter properties: Point-to-Point IP and Packet Size. Leave them at their default settings (Enabled and Automatic, respectively, as shown in Figure 9.2).



9.2: Just say no to IPX Head Compression and "record a log" for speed's sake.

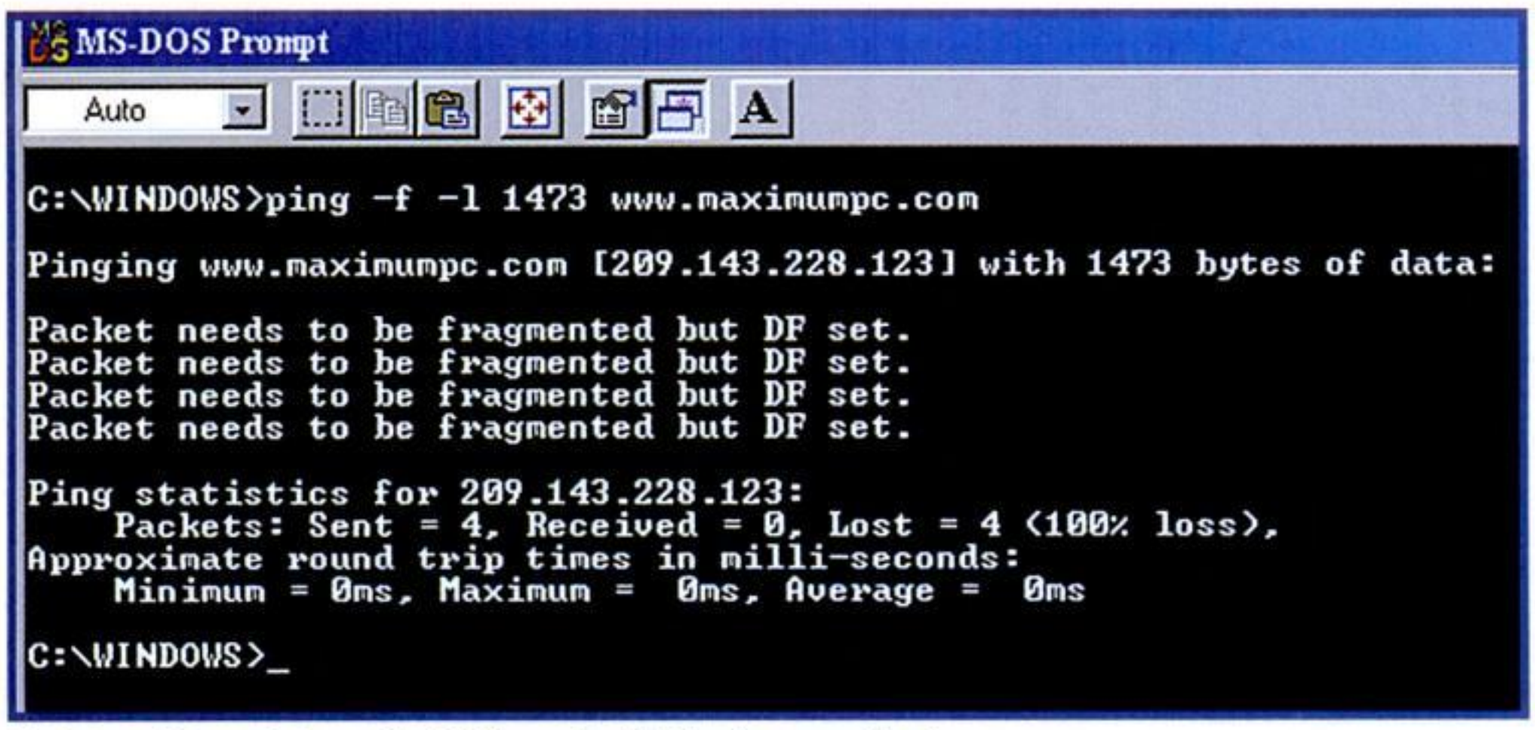
Select the TCP/IP Properties in the Network control panel. Under the Bindings tab, unmark everything for optimal TCP/IP performance. Under the NetBIOS tab, unmark "I want to enable NetBIOS over TCP/IP;" it's unnecessary for Internet connections. Under the WINS Configuration tab, select Disable WINS Resolution; it's useless since we disabled NetBIOS over TCP/IP. Under the DNS Configuration tab, select Disable DNS. If your ISP requires specific DNS settings, put them in the TCP/IP Settings section of the Dial-Up Networking properties for your Internet connection instead of making a global DNS setting here. Under the IP Address tab, select "Obtain an IP Address Automatically," as shown in Figure 9.3. If your ISP requires a specific IP address setting, put the IP address under the TCP/IP Settings section of the Dial-Up Networking properties for your Internet connection instead of making a global IP address setting here.

STEP 10 Me and you and MTU

Windows provides a plethora of TCP/IP Registry settings. The most famous, the Maximum Transmission Unit (MTU), specifies the largest amount of data (including TCP/IP header information) that can be sent per packet. Your MTU defines the size of the packets you are sending, and should be as large your net connection will support. Since Win98 has built-in MTU discovery that attempts to automatically match your MTU to your ISP's, there's little benefit to tweaking the MTU. The only time you should have to change your MTU is if you're using PPPoE over a broadband network, or are trying to set up a Virtual Private Network (VPN).

Still, Windows isn't perfect, and sometimes the Max MTU is set too small, so it's worth checking out. Your ISP's connection response

Copyrighted material


MS-DOS Prompt
Auto
C:\WINDOWS>ping -f -l 1473 www.maximumpc.com
Pinging www.maximumpc.com [209.143.228.123] with 1473 bytes of data:
Packet needs to be fragmented but DF set.
Packet needs to be fragmented but DF set.
Packet needs to be fragmented but DF set.
Packet needs to be fragmented but DF set.
Ping statistics for 209.143.228.123:
Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum = 0ms, Average = 0ms
C:\WINDOWS>_

10.1: Your ISP may tell you the MTU you should. If not, prepare to ping.

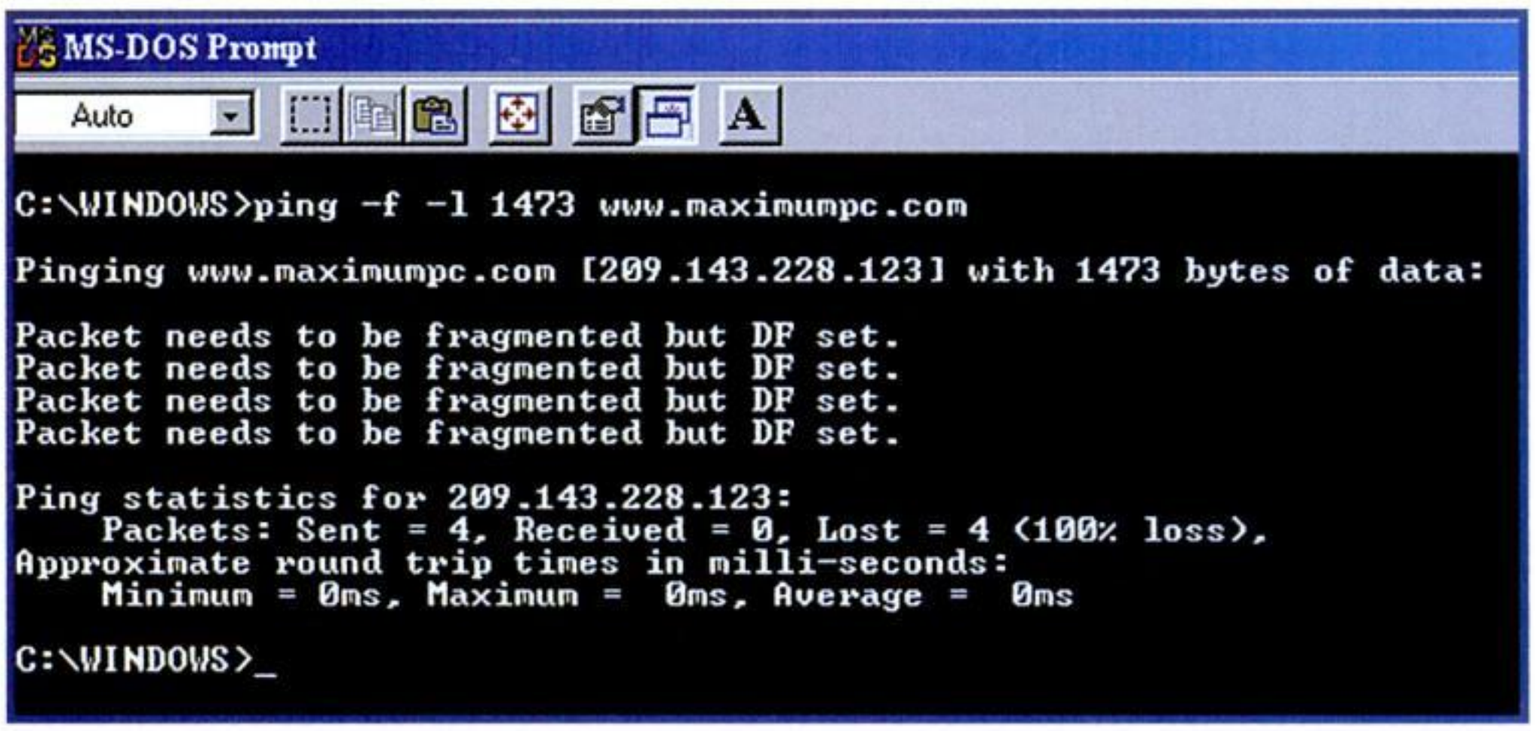
(visible in a terminal window) may provide your MTU value. If not, open an MS-DOS Prompt and PING your ISP with the -F (don't fragment packets) and -L (packet size) options, as shown in Figure 10.1. Place packet size values after the -L option until you find the highest value at which the PING command no longer responds with, "Packet needs to be fragmented but DF set" (see Figure 10.2). Start at around 1,500 and work your way down.

Once you find the value that seems to work for you, use an MTU tweak tool to make the necessary changes to your Registry. There are plenty of utilities on the web that let you manually set your MTU, but for your convenience, we've included Naviscope on the Power User CD. You do-it-yourself types can manually change your MTU value using the Registry Editor—just run Regedit and browse to **HKEY_LOCAL_MACHINE\System\CurrentControlSet\ Services\Class\Net\000x\Ndi\Params\IPMTU\enum**. Search for the 000x listing that corresponds to your active Dial-Up Adapter, add a string value named after your new MTU value, double-click the newly created string, and type "Custom" in the Value data field. Then, head back to the Dial-Up Adapter property sheet in the Network control panel and change the Packet Size setting from "Automatic" to the "Custom" option you just created.

Despite all the attention the MTU setting gets, RWIN is the real deal. The receive window (RWIN) setting is the most critical to performance, especially with broadband connections, because it specifies how much packet data (minus header information) can be enroute before the sender pauses to wait for confirmation that it was received. Pauses are bad. You want an RWIN setting large enough to avoid any pauses, and small enough to avoid long delays whenever a packet is lost and needs to be resent. The default setting for Windows is OK (though not ideal) for modems, but it's way off for broadband.

Remember, you want an RWIN that's high enough so your system doesn't waste time acknowledging every packet received, but low enough for lost or corrupt packets to be requested and retransmitted within a timely manner. Essentially, you want an RWIN setting that takes the most advantage of your connection speed and never stalls. The higher the ping to a site and the faster your connection, the more a large RWIN will help. But if RWIN is too large, error recovery is slow and your connection is less responsive. The Win98 default is 8KB, and Win2000's is 16KB. This is too small to be efficient with broadband connections, and too large for modems. If you're using a modem, set the RWIN to three times your MTU minus forty. For a broadband connection, don't worry about MTU algebra—just try 16KB, 32KB, or 64KB settings. Most likely, 32KB will work best. Most MTU tweak programs also allow you to set your RWIN, but you can opt to do it manually using the Registry editor at location **HKEY_LOCAL_MACHINE\System\CurrentControlSet\Services\VxD\MSTCP\DefaultRcv Window**.

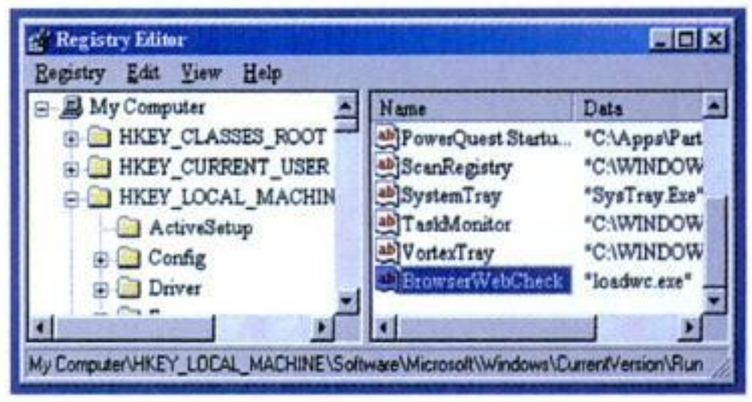
Lastly, the time-to-live (TTL) value specifies how many hops a packet can travel before expiring (it could theoretically go on forever). Leave the **TTL(HKEY_LOCAL_MACHINE\System\CurrentControlSet\Services\VxD\MSTCP\DefaultTTL)** at its default Windows value of 32.


MS-DOS Prompt
Auto
C:\WINDOWS>ping -f -l 1473 www.maximumpc.com
Pinging www.maximumpc.com [209.143.228.123] with 1473 bytes of data:
Packet needs to be fragmented but DF set.
Packet needs to be fragmented but DF set.
Packet needs to be fragmented but DF set.
Packet needs to be fragmented but DF set.
Ping statistics for 209.143.228.123:
Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum = 0ms, Average = 0ms
C:\WINDOWS>_

10.2: Increase MTU until you no longer get "fragmented" messages.

STEP 11 Clean your system

Microsoft is infamous for bloat, most of which can be removed to improve online performance. The Active Desktop portion of *Internet Explorer 5* is a resource hog, so disable it using the Display control panel. *Internet Explorer 5* and *Outlook 98* both update Internet connection components, but add a new background task (Browser Web Check) to monitor your Internet connection, automatically connecting and disconnecting upon browser activation and deactivation. If you normally use apps other than a browser, this automation may drive you crazy. Remove it using the Registry editor at location **HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\Run** shown in figure 11.1. Delete the BrowserWebCheck value. This will free up some memory in the process. Also, it's a good idea to disable ICQ clients and e-mail notification programs when you need to push your bandwidth to the limit, since they use the same connection you do.



11.1: Nuking *IE5's* browser web check in the Registry will free resources.

STEP 12 Test it

Load your favorite online game or download that file you've been putting off for comparison. You should see a more stable connection, faster response times, less lag, and of course, more kills in your next deathmatch.

Copyrighted material

The perfect mate really can make your life easier. And finding that special trackball is easy, with four choices guaranteed to fuel desire. Looking for a comfortable relationship? The Orbit® offers trackball space savings with the comfort of a mouse. A supportive partner? Our TurboBall™ offers total ergonomic support. Insist on beauty *and* brains? You'll go for the dazzling looks and high speed fingertip scrolling of the TurboRing.™ The Expert Mouse® Pro does so many things, it's almost kinky. (Let's just say you won't find a more "advanced" trackball.) All are USB and PS/2 compatible. And all will have you working faster and more comfortably than ever. So what turns you on? To pounce on one of our trackballs, visit *www.trackballs.kensington.com.*

KENSINGTON
Smart design at work.

Kensington, Expert Mouse and Orbit are registered trademarks and TurboBall and TurboRing are trademarks of ACCO World Corporation. All other registered and unregistered trademarks are the property of their respective owners. ©2000 Kensington Technology Group, a division of ACCO Brands, Inc.

Copyrighted material

Learning to Share

Sharing a modem across several PCs on a network saves money and hassle. And with multiple computers accessing the Internet via a single connection, you can throw out the sign-up sheet for your household's Internet terminal. Faster Internet access is becoming the norm, so there's more than enough bandwidth to share with every PC in your house.

Connection sharing has major benefits. If you currently have multiple phone lines and ISP accounts linking your various machines to the net, you'll save money by canceling those unneeded services. And with only one connection to maintain, you'll have fewer configuration hassles. It's never been easier to share a single Internet connection, and we'll show you how to do it from the ground up.

—Fabian Echevarria

The Basics

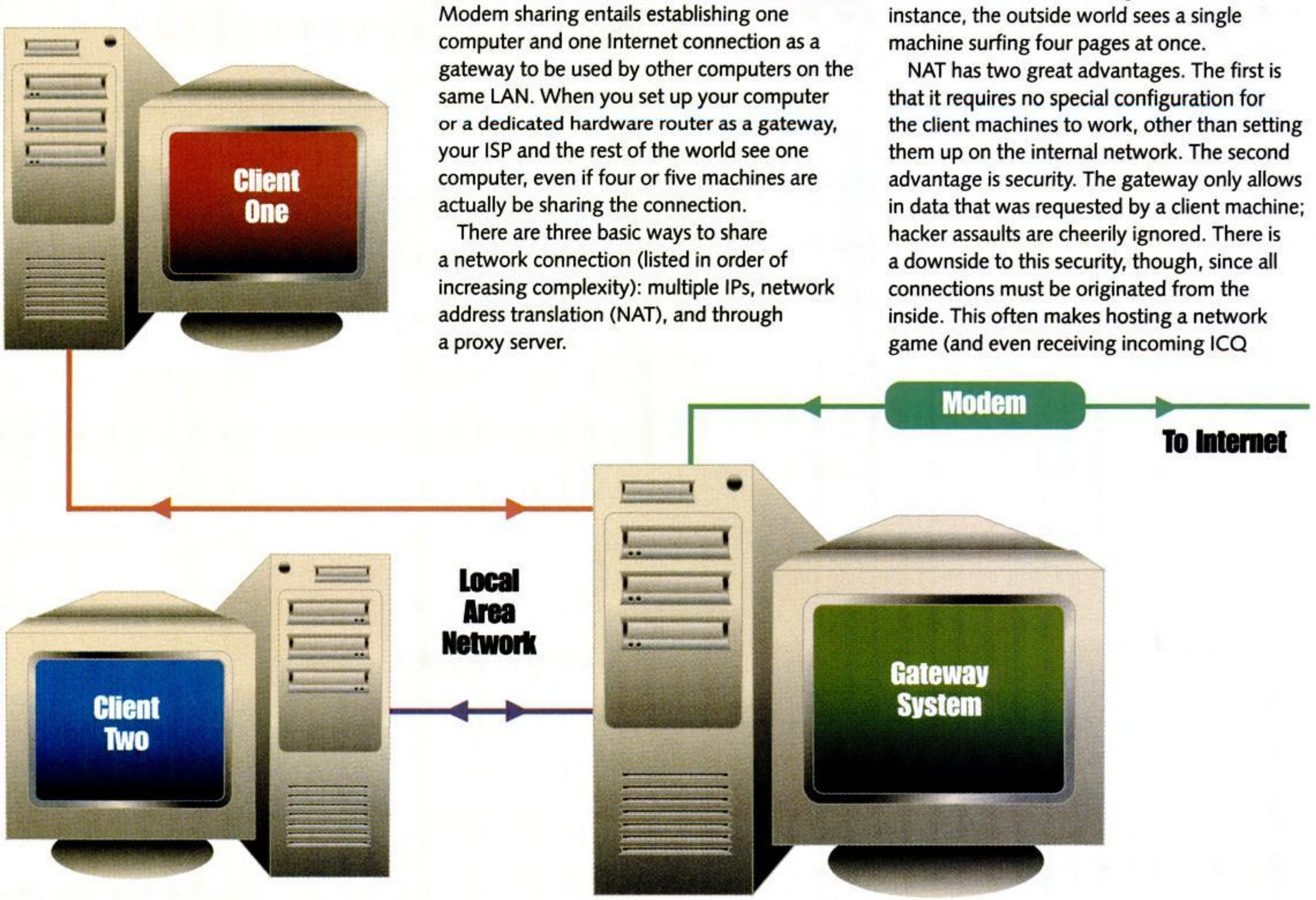
Modem sharing entails establishing one computer and one Internet connection as a gateway to be used by other computers on the same LAN. When you set up your computer or a dedicated hardware router as a gateway, your ISP and the rest of the world see one computer, even if four or five machines are actually be sharing the connection.

There are three basic ways to share a network connection (listed in order of increasing complexity): multiple IPs, network address translation (NAT), and through a proxy server.

Some cable modem and DSL companies offer multiple IP addresses, usually at an additional monthly charge. This gives you separate Internet addresses for each computer on your home network, so in truth, there's no sharing involved with multiple IPs—other than sharing the line—because each PC has a totally independent connection to the Internet. The great advantage here is that there are no compatibility or performance issues that the other solutions might introduce. On the downside, the machines on your network don't benefit from the additional security that other connection-sharing methods provide.

If you have only one IP address to work with (typical for modem users), you can share your connection through a NAT or proxy server. The more flexible of the two is NAT. Using NAT, all the machines within your home network are given unique IP addresses on a private network (usually 192.168.0.xxx). The gateway machine translates traffic from the internal network into requests originating from a single IP going out the external network. The NAT gateway keeps track of all outgoing connections, and when the incoming response returns, the NAT sends it to the machine on the internal network that made the request. If four machines on the internal network are surfing the web, for instance, the outside world sees a single machine surfing four pages at once.

NAT has two great advantages. The first is that it requires no special configuration for the client machines to work, other than setting them up on the internal network. The second advantage is security. The gateway only allows in data that was requested by a client machine; hacker assaults are cheerily ignored. There is a downside to this security, though, since all connections must be originated from the inside. This often makes hosting a network game (and even receiving incoming ICQ



Copyrighted material

messages) difficult to set up—requiring small "pinholes" to be configured in the NAT.

The third method of connection sharing is to use a proxy server. A proxy server functions at the application level, not at the network level like NAT does. Because of this, every client application—not just the system, but every network application you wish to use—must be configured to use the proxy server running on your gateway machine. This makes things a lot more complicated. In return, though, a good proxy will block out all unwanted external connections, route data through the appropriate network protocols to the outside world, and cache often-used web pages. But because of the added complexity, proxies can often slow down your connection.

Even with a full-featured proxy and a high-speed LAN, the Internet connection type—whether modem, DSL, or cable—will still limit the total bandwidth that can be shared. Don't expect to play multiplayer deathmatches on every networked machine through your single 56K modem; the total amount of data that can be sent and received through a single Internet connection doesn't grow when you have multiple PCs sucking on the pipe. If you're looking to route bandwidth-heavy data streams through a proxy, you'll need a connection device capable of meeting those requirements. Only DSL, certain cable modems, and to a lesser degree ISDN, will deliver adequate performance in this situation.

Shared Surfing

Several companies provide modem-sharing software, with prices that range from free to very expensive—and as with most things, higher expense translates into more features and capabilities. Low-end solutions provide the basics, such as Network Address Translation (NAT). Mid-range solutions tack on useful features such as the ability to filter traffic (a.k.a. firewall functions). High-end solutions usually provide many proxy and caching features, as well as "holes" that let you run a server visible to the outside world from behind your gateway.

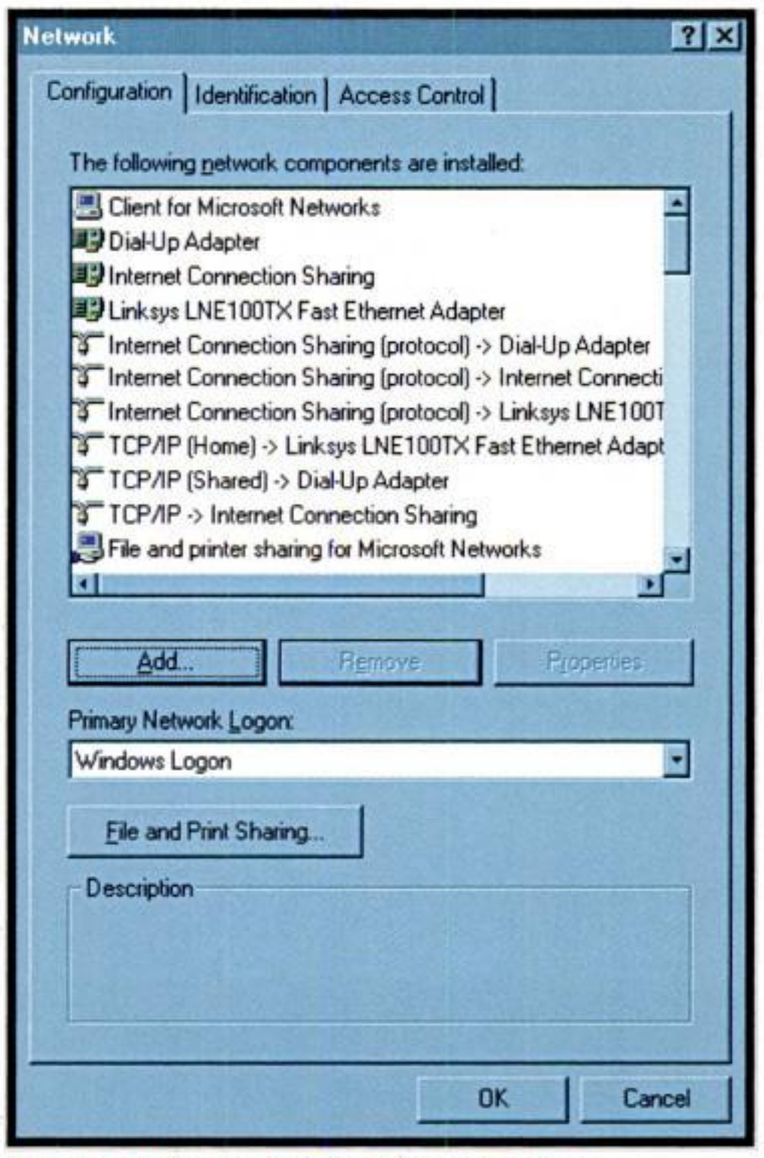
There's a ton of modem-sharing packages out there, but we're focusing this how-to on the new Internet Connection Sharing feature included in Windows 98 Second Edition and Windows ME. The Windows ICS is a fairly basic NAT that includes basic firewall services, simplified versions of a DHCP server and a DNS server, and a 254-user limit. And of course, it's free. ICS's one major drawback is that it can't cache web pages.

STEP 1 Set Up the Gateway

If you haven't already, network your computers using any of the methods showcased in the August 1999 *Maximum PC* feature, "Down-Home Networking." Once your LAN is up and running, select one computer to act as the gateway. The gateway computer must be able to run Windows 98 Second Edition, so it must at least meet that OS's minimum system requirements (486DX/66MHz, 24MB RAM, 205MB hard drive space). Also be aware that this machine must be turned on in order for any of your other machines to reach the network, and that your internal machines are protected behind a NAT, but this gateway is exposed and needs protection. We recommend the excellent ZoneAlarm personal firewall software included on the Power User CD. Since your gateway machine is essentially outside of the shared network, it also may prove to be the only machine that can act as a network game host, or be able to play online deathmatches at all.

Internet Connection Sharing Wizard
Welcome to the Internet Connection Sharing Wizard.
This wizard helps you to set up your computer to share an internet connection with other computers in your home network, allowing them to simultaneously access the Internet.
Use an Internet connection you've already set up and your Internet Service Provider account.
Run the Internet Connection Sharing Wizard only on the computer your network uses to connect to the Internet.
Click Next to continue or Cancel to exit the wizard.
< Back
Next >
Cancel

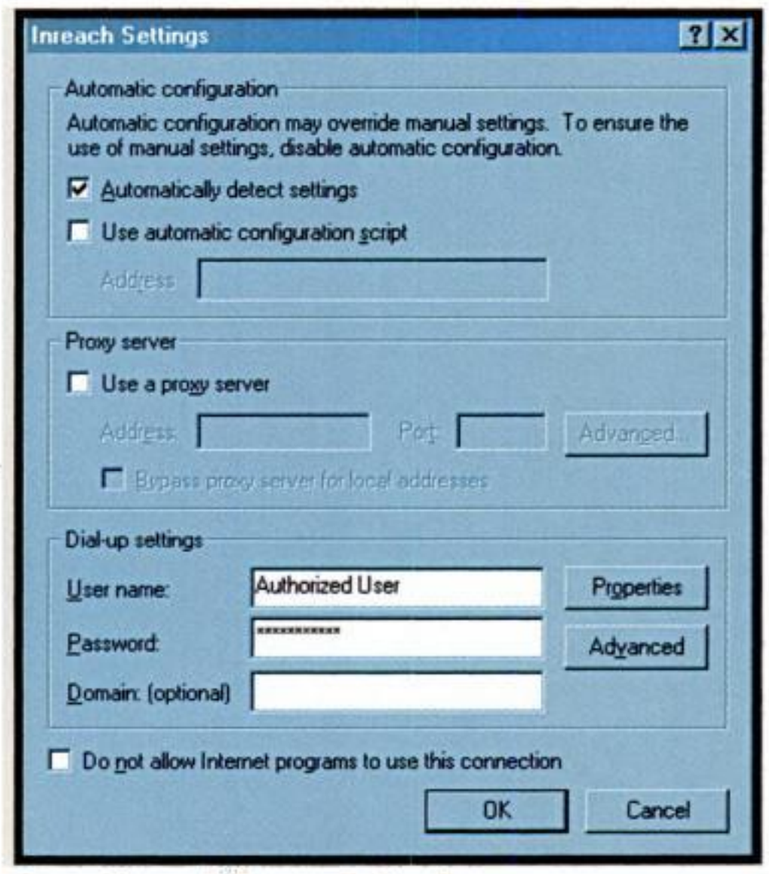
In Windows 98 SE, ICS setup and activation are wizard driven. To activate the wizard, go to the Windows Setup tab of the Add/Remove Programs Control Panel and select Internet Connection Sharing from Internet Tools.



After installing Win98's ICS, you'll notice that several new Network components have been added to your system, and that a few preexisting components have been changed.

STEP 2 Specify Connection Settings

If you're using multiple ISPs, set your preferred connection as the default by accessing the Connections tab of the Internet Option Control Panel, clicking on the Settings option, selecting Automatically Detect Settings, then entering the correct username and password for your preferred connection. The browser-check service provides only limited connection-behavior control; for example, a failed attempt to connect to the default connection doesn't result in an attempt to hit up the secondary ISP choices. When that first attempt fails, the system simply waits for divine intervention—or yours, whichever comes first.



Do not to mark the very last option, "Do not allow Internet program to use this connection," because it will keep Internet programs from activating your connection on demand.

WARNING: Win98 SE's Internet Connection Sharing will not work if your connection uses separate devices for upstream and downstream data channels. Sadly, this includes certain cable modems that use a standard modem connection for the upchannel portion of the data stream, as well as most satellite-based (Direct PC and other) systems, which have connections that work in the same manner.

Copyrighted material

STEP 3 Choose An IP Pool

ICS defaults to a Class C address pool beginning at 192.168.0.1 and ending at 192.168.0.255 (hence, the 254-user limit), mainly because this IP address pool falls into a range of reserved, nonroutable IP addresses. Although the Internet community has reserved this address pool for private Class C networking, you can change ICS's default Class C pool to one of your choosing: Simply change the internal IP address listed in the TCP/IP (Home) properties of the host computer. But leave the subnet mask at 255.255.255.0; this allows you to keep an existing static IP address for your LAN if you've been using TCP/IP as one of your LAN protocols, while still allowing access through the host computer.

STEP 4 Make Sure PCs Can TCP/IP

Since the ICS client setup disk configures just the browser, you must manually configure the TCP/IP settings on each client machine. If the TCP/IP protocol isn't currently installed on each machine, add it through the Network Control Panel.

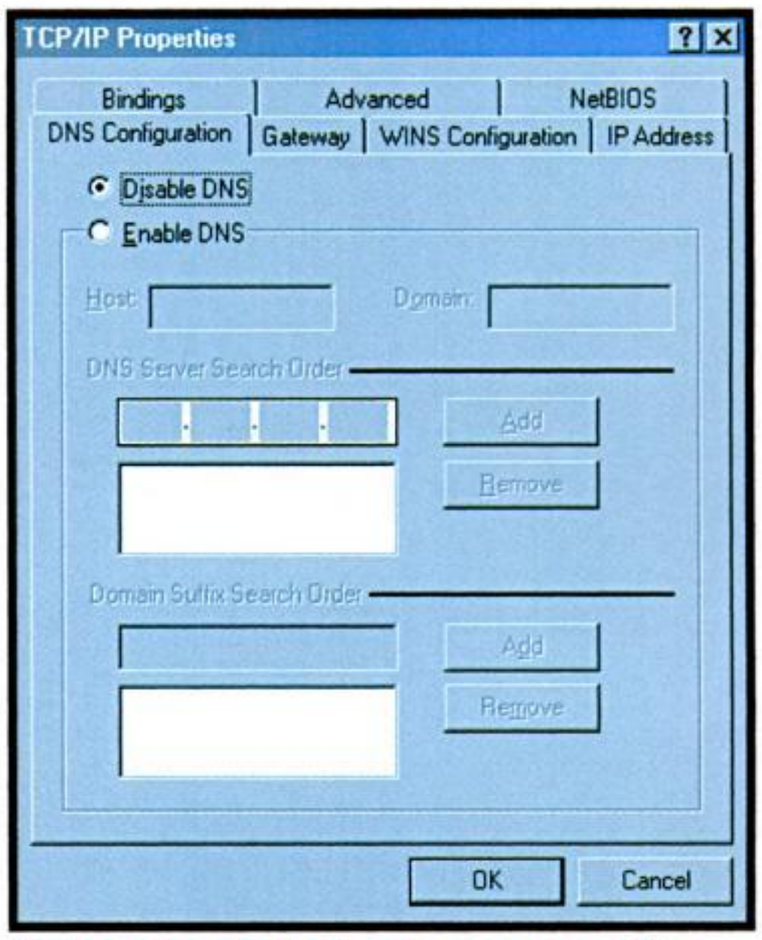
If your LAN already speaks TCP/IP, it probably does so through static IP addresses. In this case, you'll need to venture into each machine's Network Control Panel, and under the IP Address tab in the TCP/IP properties of your LAN card, select Obtain an IP Address Automatically. This will enable you to use the DHCP-leased settings. Also, for optimal performance, remove unnecessary network components. If you don't use IPX/SPX, remove it. And feel free to ditch NetBEUI; to share files, you just need Microsoft's File and Printer Sharing Service. Reboot to implement the changes.

Manually entered settings always take priority over DHCP-leased information—keep this in mind, or you could inadvertently prevent Internet sharing on a client machine. DHCP is a protocol that allows a client's network settings to be configured automatically by a DHCP server. In this case, the ICS gateway machine acts as the DHCP server, and all the clients can use DHCP to avoid any manual IP configuration issues.

STEP 5 Set Up the Client

After ICS is installed on the gateway PC and TCP/IP is installed on each client PC, it's time to configure the client PCs' browsers. To do this, run the Browser Connection Setup Wizard on each client machine, from the floppy disk that was created by the ICS installation program.

The documentation for the client configuration program mentions compatibility with only *Internet Explorer 3* and up. For *IE 4* and *5*, simply enter the Internet Options Control Panel and select Automatically Detect Settings under the LAN Settings connection option. If you're partial to another browser, refer to its documentation in order to locate the specific settings for LAN-based Internet access. The only thing you need to remember is to tell your browser that you are "connected to the internet via LAN," and that it no longer needs to worry about triggering your modem.



While you're under the hood, remove any existing gateways listed under the Gateway tab or DNS servers under the DNS Configuration tab.

STEP 6 Test It

ICS includes dial-on-demand capabilities, so any client computer requesting an Internet connection will automatically activate the host connection. Be sure your host machine and all your client machines can access the Internet properly before inviting your friends and family over to view your handiwork. Use a client computer to activate ICS on the gateway computer, then view several web pages using both a web server's IP address and its URL. This will test for connectivity and verify that the DNS proxy can correctly convert a URL into its IP address. Also, check your e-mail, and play an online game or two to ensure that everything is being properly routed out to the net and back again.

STEP 7 Share It

As long as DSL and cable proliferate and ISDN costs keep plummeting, there's no reason not to set up your own miniature ISP, giving everyone in your house sufficient bandwidth. You could wind up saving yourself the cost of redundant phone lines and ISP accounts, and the headache of placating disgruntled members of your household who've been waiting to get online.

Just keep in mind that most online multiplayer games require some tricky configuration to work through a shared connection; at worst, they won't work at all. With most games, only a single player can be behind a shared connection at once, so you can't have your whole clan over, log onto the net together, and whup ass as a group through a single shared connection. If you're interested in a shared connection that can do that, you'll probably need to go with a hardware solution.

Other ways to share

Sharing duties can be handled by software or hardware, so when you're looking for the best way to share your connection, here's what you should consider:

Because a proxy acts as your agent to the Internet, translating all outgoing and incoming requests, it's in a perfect position to cache frequently accessed information and graphics on your hard drive, resulting in up to 60 percent faster response times. While not all proxies include such a capability, a caching proxy with optimal settings and enough hard drive space can make a shared 56K connection feel like a mainline of pure Internet speed. A mid- to high-end software-based proxy would be your best choice, if web caching interests you.

Since it's the only machine directly connected to the Internet, a proxy can also serve as a barrier between your network and the outside world, or a firewall. When connecting a network to the Internet, security should be your primary concern. Choose a proxy that can configure itself as a firewall for your internal network. Most products act as a firewall right out of the box, though some require additional configuration, especially if you want to create a hole or two in the firewall, which will allow you to host a multiplayer game or receive incoming ICQ alerts. Read the documentation that comes with your connection-sharing choice and implement the settings that will best protect your network.

Hardware gateways are great low maintenance solutions and they come in several shapes and sizes, from intelligent hubs to combo modem/routers. Some gateways provide serial ports into which you can jack your connection device, allowing you to start small with a modem and work your way up to faster connections such as ISDN. Others are incorporated into the connection device itself. Hardware gateways exist for almost every routing need and use. You can find a hardware router with NAT support for between $100 and $500, depending on features.

Hardware proxies are a little more expensive, but well worth it for anyone who has a cable or DSL connection. With a hardware proxy, you never have to worry about your gateway "crashing," and there isn't one particular computer in your house that must be left on all the time. Also, they give you the free firewall side effect, unlike software solutions, which still expose your gateway PC to hackers.

Copyrighted material

Illustration never looked so good.

Eye-catching illustration, isn't it? And yes, despite the glistening highlights, the realistic textures, the subtle shading, and the soft air-brushed effects, this is a completely vector illustration. And it's only possible with Canvas 7.

Match pinpoint precision with painterly strokes through Canvas 7's exclusive Sprite technology. Blur vector lines, paint transparency effects, apply image filter plug-ins to vectors, text and images. It's hard to believe that you can draw like this – never mind in one, attractively priced program. When you're done, prepare your creative visions for print or web with an incredible array of over 40 file format filters.*

Feast your eyes on Canvas 7 today, and get a whole new outlook on illustration software.

Now available in Professional and Standard Editions.

Get Canvas 7 today!

Professional Edition	$375
Competitive Upgrade	$199.95
Standard Edition	$99.95

www.deneba.com/pc
800.7DENEBA

DENEBA

CANVAS™ 7

No comparison.

DENEBA

© 2000 Deneba Software. This ad was created using nothing but Deneba Canvas 7. Canvas, SpriteEffects and SpriteLayers are trademarks of Deneba Systems, Inc. For more information send email to sales@deneba.com.

* 40 file formats available in Canvas 7 Professional Edition only.

Copyrighted material

22 Nanoseconds in the Life of a CPU

HOW AN INSTRUCTION WINDS THROUGH THE ATHLON

When it comes down to it, all a CPU really does is rearrange and add up binary numbers. All the other arithmetic functions—such as division, multiplication, or computing square roots—are implemented via a very fast series of bit shifts and additions. Turning instructions that specify high-level operations into simple steps that the CPU can handle quickly is complicated process. A close look at the die of AMD's Athlon hints at the complexity of the hardware needed to wring the last drop of performance from today's x86 application code. Buffers, control units, caches, execution units, and other components all work together to the beat of a 1GHz pulse, pushing instructions and data through the Athlon as fast as possible.

In order to process instructions quickly, the Athlon divides the execution of each instruction into various stages. These stages, taken together, are called the pipeline. The Athlon moves instructions through the pipeline's stages like cars through an assembly line—except that in the Athlon's case, the pipeline is more of a "disassembly line." Since the Athlon's insides can't process the large, unwieldy x86 instructions, it uses a two-stage digestion process to break them down before actually crunching them.

The first stage of this process is the "early decode" stage, in which Athlon translates the x86 instructions into a special, internal format called a MacroOP—a RISC-like instruction that the Athlon uses for scheduling and tracking purposes. x86 instructions aren't uniform in size or functionality, so by breaking them down into uniform, easily managed MacroOPs, the Athlon can move them around and keep track of them much more efficiently.

In the early decode stage, there are two possible paths an x86 instruction can take on its way to becoming a MacroOP. The first path, called the DirectPath, is taken by the smaller and more uniformly sized of a program's x86 instructions. Each x86 instruction that is DirectPath-decoded is turned into exactly one MacroOP, making the DirectPath the most efficient and optimal decoding path. Modern x86 compilers know that these shorter instructions are best, so the majority of the x86 instructions that the Athlon encounters are DirectPath-decodable. The second decode path is the VectorPath. This is the path taken by more unwieldy x86 instructions. VectorPath instructions are decoded by a microcode engine, and usually decode into more than one MacroOP.

Once an instruction becomes a MacroOP, it can be scheduled for execution. It can't, however, be executed. In order for the Athlon's execution units to actually execute the MacroOP, the MacroOP must enter a "final decode" stage, where it is further broken down into an even smaller instruction format called an OP. Each MacroOP breaks down into either memory access OPs or regular instruction OPs such as add, multiply, and divide calculations. It is the OP that the Athlon's Floating-Point and Integer Execution Units actually execute.

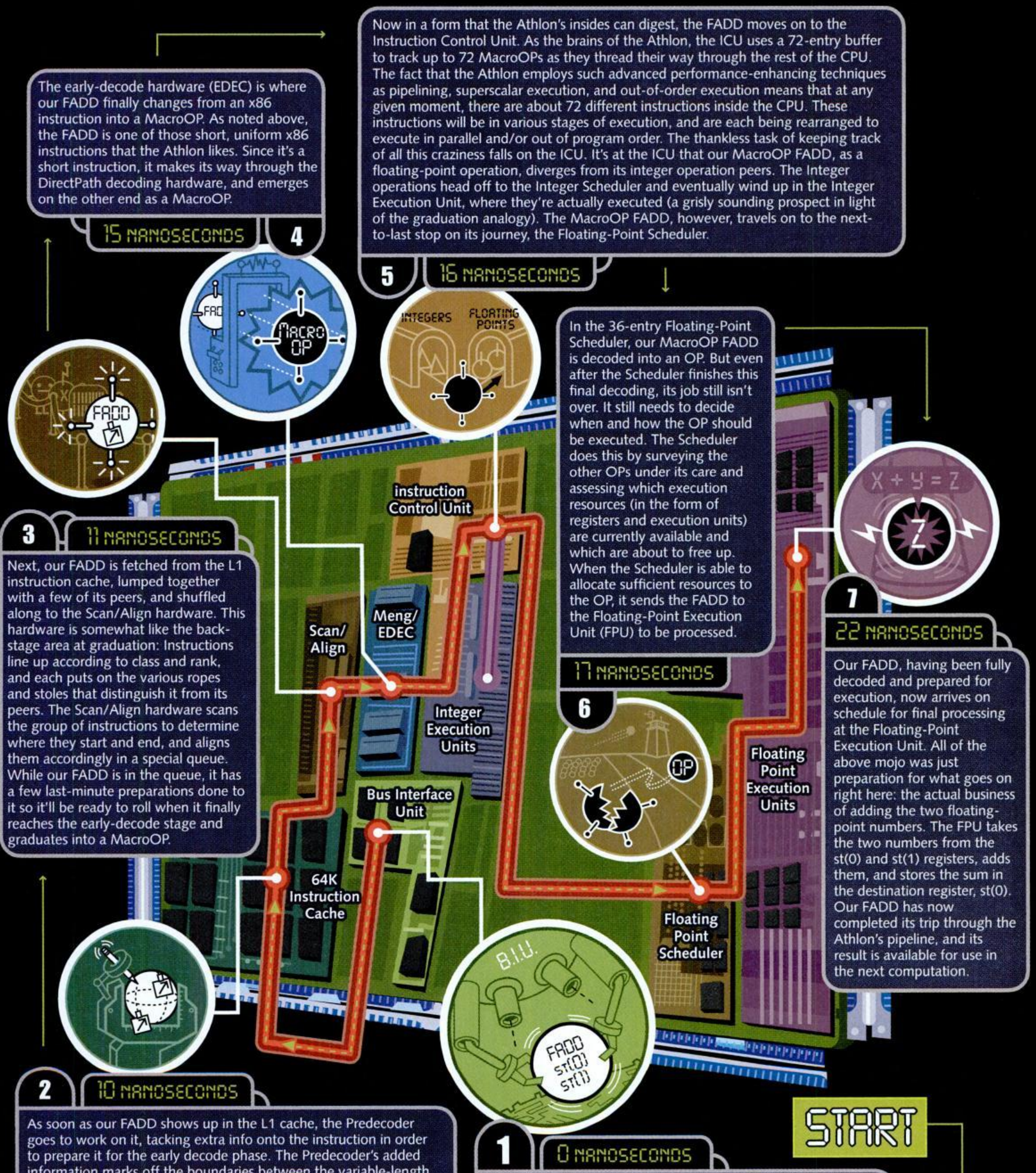
To get a clearer understanding of how this works, we tracked a floating-point addition instruction—FADD st(0), st(1)—through the Athlon's insides. But before we actually describe the instruction's path through the CPU, we should get more acquainted with the instruction's basic format.

In our example instruction "FADD st(0), st(1)," the term to the far left, "FADD," specifies that the operation to be performed is a floating-point addition. The second two terms, "st(0)" and "st(1)," tell the Athlon which registers contain the two numbers to be added. The registers' job is to hold, in an easily accessible spot, both the data on which operations are performed and the results of those operations. Think of registers as pieces of scrap paper on which the CPU jots down the numbers it's currently working with. Our FADD instruction takes whatever values are currently held in registers st(0) and st(1), adds them together, and places the result in st(0). Whatever number was previously stored in st(0) gets overwritten.

In the following seven steps, we'll track our FADD as it makes its way from RAM down to the Floating-Point Execution Units. It'll first stop off in the L1 cache, and from there it'll make its way into the early decode stage. After it has been early decoded, it will enter the ICU so it can be dispatched to the FPU, where it will finally be executed.

—Jon Stokes

Copyrighted material


Now in a form that the Athlon's insides can digest, the FADD moves on to the Instruction Control Unit. As the brains of the Athlon, the ICU uses a 72-entry buffer to track up to 72 MacroOPs as they thread their way through the rest of the CPU. The fact that the Athlon employs such advanced performance-enhancing techniques as pipelining, superscalar execution, and out-of-order execution means that at any given moment, there are about 72 different instructions inside the CPU. These instructions will be in various stages of execution, and are each being rearranged to execute in parallel and/or out of program order. The thankless task of keeping track of all this craziness falls on the ICU. It's at the ICU that our MacroOP FADD, as a floating-point operation, diverges from its integer operation peers. The Integer operations head off to the Integer Scheduler and eventually wind up in the Integer Execution Unit, where they're actually executed (a grisly sounding prospect in light of the graduation analogy). The MacroOP FADD, however, travels on to the next-to-last stop on its journey, the Floating-Point Scheduler.
The early-decode hardware (EDEC) is where our FADD finally changes from an x86 instruction into a MacroOP. As noted above, the FADD is one of those short, uniform x86 instructions that the Athlon likes. Since it's a short instruction, it makes its way through the DirectPath decoding hardware, and emerges on the other end as a MacroOP.
15 NANOSECONDS
4
5
16 NANOSECONDS
FAD
MACRO OP
INTEGERS
FLOATING POINTS
FADD
In the 36-entry Floating-Point Scheduler, our MacroOP FADD is decoded into an OP. But even after the Scheduler finishes this final decoding, its job still isn't over. It still needs to decide when and how the OP should be executed. The Scheduler does this by surveying the other OPs under its care and assessing which execution resources (in the form of registers and execution units) are currently available and which are about to free up. When the Scheduler is able to allocate sufficient resources to the OP, it sends the FADD to the Floating-Point Execution Unit (FPU) to be processed.
X + Y = Z
Z
7
22 NANOSECONDS
Our FADD, having been fully decoded and prepared for execution, now arrives on schedule for final processing at the Floating-Point Execution Unit. All of the above mojo was just preparation for what goes on right here: the actual business of adding the two floating-point numbers. The FPU takes the two numbers from the st(0) and st(1) registers, adds them, and stores the sum in the destination register, st(0). Our FADD has now completed its trip through the Athlon's pipeline, and its result is available for use in the next computation.
17 NANOSECONDS
6
OP
instruction Control Unit
Scan/ Align
Meng/ EDEC
Integer Execution Units
Bus Interface Unit
64K Instruction Cache
Floating Point Execution Units
Floating Point Scheduler
B.I.U.
FADD st(0) st(1)
3
11 NANOSECONDS
Next, our FADD is fetched from the L1 instruction cache, lumped together with a few of its peers, and shuffled along to the Scan/Align hardware. This hardware is somewhat like the back-stage area at graduation: Instructions line up according to class and rank, and each puts on the various ropes and stoles that distinguish it from its peers. The Scan/Align hardware scans the group of instructions to determine where they start and end, and aligns them accordingly in a special queue. While our FADD is in the queue, it has a few last-minute preparations done to it so it'll be ready to roll when it finally reaches the early-decode stage and graduates into a MacroOP.
2
10 NANOSECONDS
As soon as our FADD shows up in the L1 cache, the Predecoder goes to work on it, tacking extra info onto the instruction in order to prepare it for the early decode phase. The Predecoder's added information marks off the boundaries between the variable-length x86 instructions, and lets the early-decode hardware know whether our FADD is a DirectPath or VectorPath instruction. Since our FADD is a DirectPath instruction, when it hits the early-decode stage, it will be decoded directly in hardware, as opposed to passing through the Athlon's microcode engine as a VectorPath instruction would.
START
1
0 NANOSECONDS
Before the Athlon can put our instruction into the pipeline, it must fetch it from main memory, where the most recently used portions of the program's code are temporarily stored. The Athlon's Bus Interface Unit (BIU) does the actual work of fetching the FADD and loading it into the L1 instruction cache, which is the first stop for all instructions on their way into the CPU. The BIU is the Athlon's liaison with the rest of the memory system; when the Athlon needs a piece of code or data, the BIU is there with the hook-up.

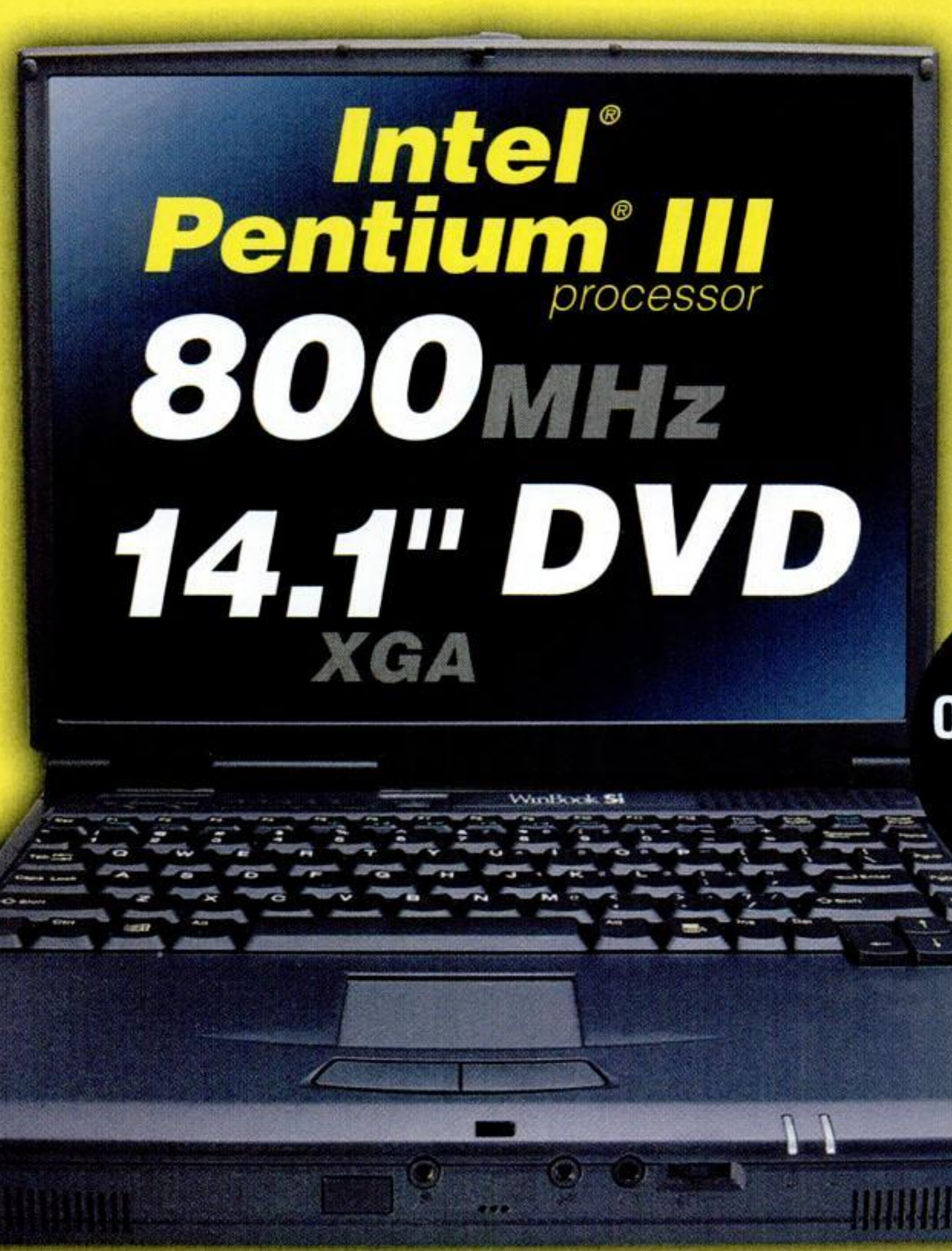
Copyrighted material

Price Breakthrough

WinBook Si

intel inside pentium® III

$1999



If it's power you want, this Intel® Pentium® III processor 800 MHz will fly through whatever you give it—the biggest spreadsheets, the most demanding graphic programs, complex web designs or the fastest 3-D games. With a 14.1" XGA screen and a DVD, this system has all the features you need!

- Intel® Pentium® III processor
- 800 MHz
- Thin (1.6") & Lightweight (7.1 lbs.)
- 14.1" XGA Active Matrix Color Display
- 64 MB SDRAM, upgrade to 256 MB
- 6 GB Ultra DMA Hard Drive
- ATI 3D Mobility Graphics Accelerator with Integrated SDRAM
- 56k† Capable v.90 Internal Fax/Modem
- Lithium Ion Smart Battery
- 256k Integrated L2 cache On-chip
- 3.5" Floppy Disk Drive, built-in
- DVD-ROM Drive built-in, no need to swap
- Integrated Dual-Button Touchpad
- 2 Type II or 1 Type III PCMCIA slots, CardBus and Zoomed Video supported
- 1 Year Limited Extendable Warranty
- Microsoft Windows® pre-installed
- Free Internet Access pre-installed

Winner of over 200 awards.
Visit www.winbook.com for more award information.

Increased RAM, Increased Power and CD-RW for a great LOW PRICE! Vist our website today!

Additional Price Breakthroughs available at www.winbook.com!

Order Online at:

www.winbook.com 800-339-3746

†56k modems are capable of 56 kps downloads. Due to FCC rules that restrict power output, however, current download speeds are limited to 53 kps. Upload speeds are limited to 33.6 kps. Actual speeds may vary depending on line conditions. Prices and specifications valid in U.S. only and subject to change without notice. All purchases are subject to availability. For a complete copy of Guarantees and Limited Warranties, contact WinBook Computer Corporation or our website at www.winbook.com/warranty.html. ®2000 WinBook Computer Corporation and My Favorite PC.com. All rights reserved. WinBook is a registered trademark of Micro Electronics, Inc. All rights reserved. Intel, the Intel Inside logo and Pentium are registered trademarks of Intel Corporation.

WinBook®
Critically Proven.

Copyrighted material

How Data Moves Around Your Motherboard

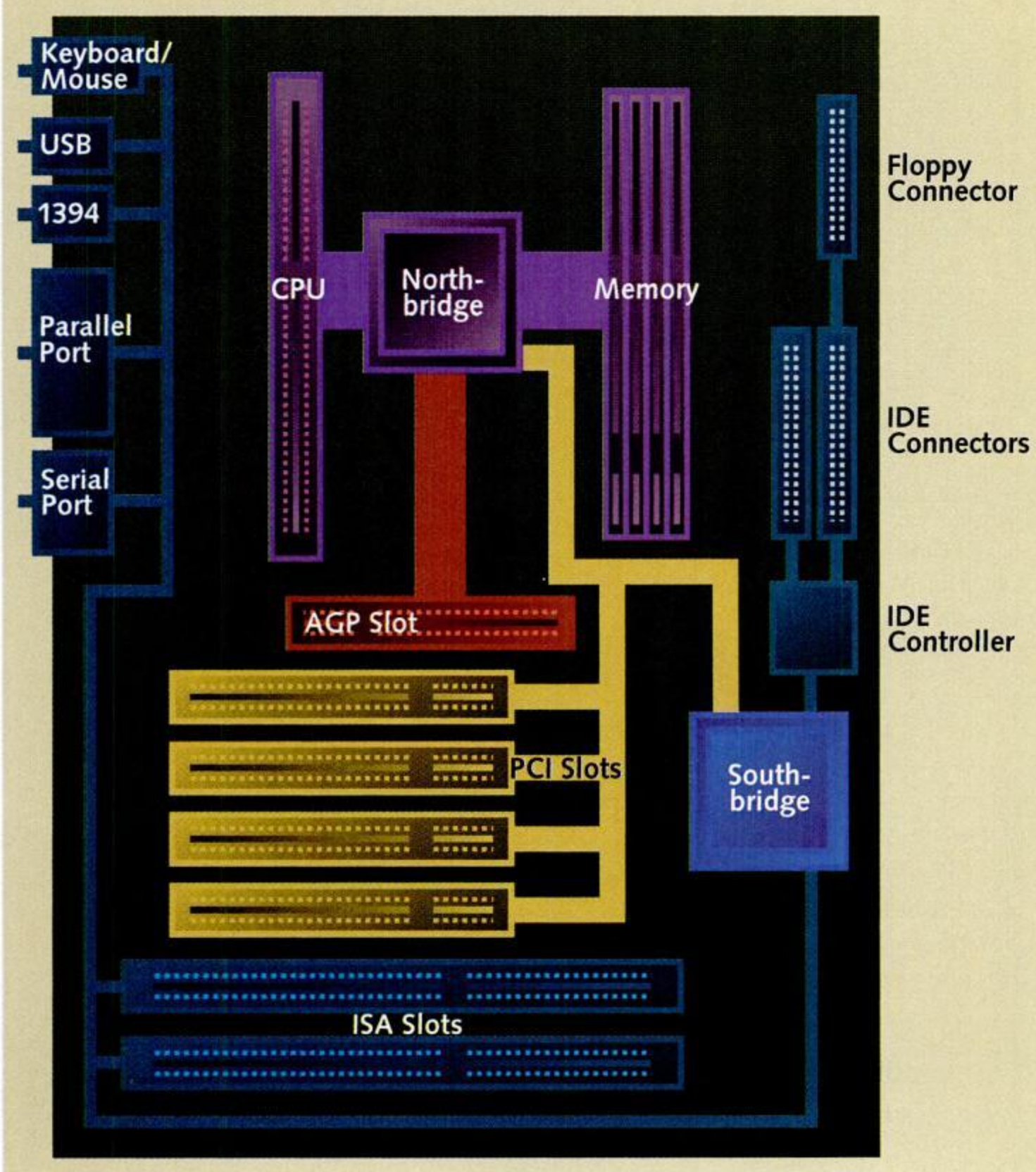
If one plane flying from Seattle to Florida stops in St. Louis, and another plane flying from New York to Seattle stops in Detroit, how many airline personnel will it take to restrain the angry passengers who've eaten nothing all day but a bag of heavily salted peanuts?

No, we don't want you to become a flight attendant (your mother wants you to be a doctor, and we're not tangling with her), but we do want to get you up to speed on the way data moves around your motherboard. It happens much like the way the airline industry moves folks around—as many passengers as possible are packed together and shuttled as quickly as possible from one place to the next according to a predetermined route, with specific stops made along the way.

Just as there are limits on the number of planes that can fly the friendly skies at once, the number of routes and the speed at which data can travel through your motherboard limits your system's throughput and performance. Our goal is to arm you with enough information to make good choices when purchasing components for your system. In the event of an emergency, please place your head between your knees in preparation for landing. *—Sean Cleveland*

BUS ROUTES

The traditional Pentium II and III motherboard architecture uses northbridge and southbridge chips to control the flow of data around the various buses. Although not as efficient as Intel's new hub design, the old architecture pulls together several different buses that run at varying speeds and makes it all work.



The Core-Logic Chipset

Your motherboard's core-logic chipset acts as the air traffic controller that directs the movement of data between all of your computer's devices. Often referred to by proper name, such as Intel 440BX or VIA MVP3, the core-logic chipset regulates the system speed and directs all instructions from the CPU and memory to the buses that connect every device and peripheral in your machine. For more on core-logic chipsets check out "Chipset Shop Talk" on page 83.

Buses are the electrical pathways through which your machine's internal components communicate with one another—in the airline analogy, buses are the flight patterns. They are defined by bandwidth, or their data capacity (measured in bits) multiplied by the speed at which they can carry data (measured in megahertz). For more info on calculating your bus's bandwidth, check out the "How big is you bus?" sidebar on page 64.

In terms of capacity, a serial bus is a little-used local flight, while the system memory and CPU buses are major corridors. Recent motherboard buses are increasing this load even further, essentially carrying twice as much data on the same number of flight patterns without flying any

Copyrighted material

faster. DDR memory and AGP 2x are good examples of this, since they both communicate on the rising and falling edge of the clock pulse to move twice as much memory across the bus.

Each expansion slot on your motherboard branches off into a bus, and each bus is named after the slot with which it is associated. ISA, PCI, and AGP buses are the most familiar names to many PC users, but others—particularly the system and memory buses—play important roles in making your PC be all it can be.

System Bus

Your PC's system bus is like the L.A.-to-New York flight pattern—it's a main artery. The system bus links the CPU to the core-logic chipset, which coordinates data flow for each device and peripheral connected to the motherboard. The width, or capacity, of the system bus on all modern PCs is 64 bits, so systems that support a 100MHz system bus have a total bandwidth of 800MB/sec.

You'll find that only Celerons are still cramped at a lowly 66MHz bus (unless you overclock them, of course). Both Intel and AMD have significantly expanded the data rate of the system bus in their current chipsets. The Intel 820 and 840 chipsets support a 133MHz system bus, and the AMD-750 chipset powered by the Athlon supports a 100MHz double-pumped system bus, which is capable of cranking 1.6GB/sec of raw bandwidth to and from the CPU.

From your CPU's perspective, the system bus is also often referred to as the frontside bus (FSB), distinguishing it from the private backside bus (BSB) that your CPU uses to speak to its L2 cache. This dual bus architecture was introduced in the Pentium Pro—formerly, L2 cache was present on the system bus, slowing things down—and is now used in all the latest CPU's from both AMD and Intel.

The backside bus keeps the processor from seeking data from slower devices, such as main system memory or hard drives, and therefore wasting clock cycles. Since data instructions are stored sequentially in the cache, the backside bus can quickly retrieve each instruction from there, one after the other, garnering another boost in system performance.

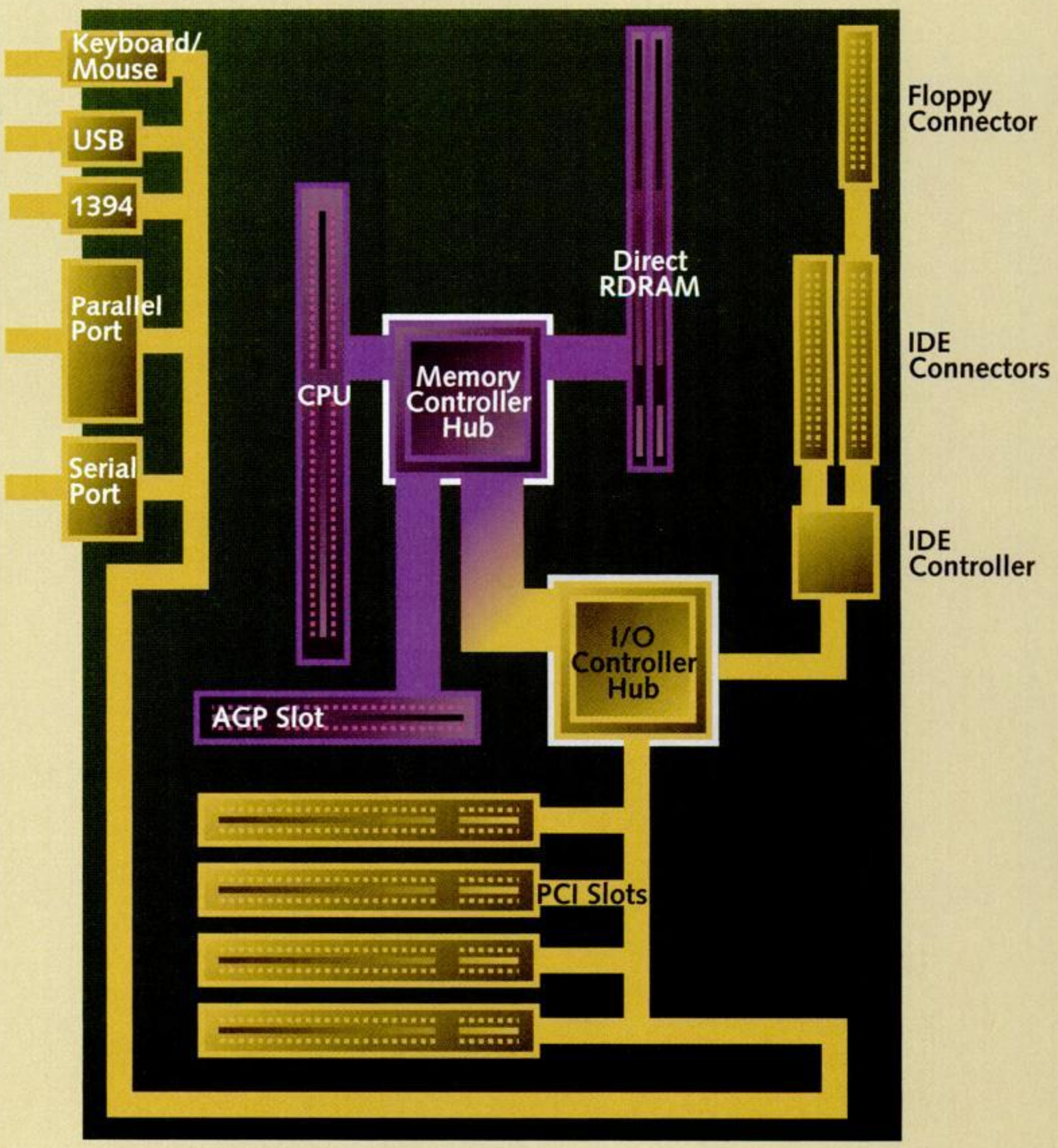
Since the backside bus is private to the CPU, there's a lot of flexibility in how fast it can be clocked. The original, cartridge-based Pentium II's had separate cache chips on the cartridge, connected over a BSB that was running at one half the processor's core speed. The first Athlons also functioned this way. More recently, the L2 cache has been brought internal to the CPU, allowing the BSB to run full speed ahead. On a 1GHz

HOW BIG IS YOUR BUS?

To calculate the bandwidth of a bus, multiply its speed by its width. A bus's speed is measured in megahertz (MHz); its width is measured in bits, but you'll need to convert it to bytes by dividing the number of bits by eight. For example: The PCI bus is 32 bits (4 bytes) wide; it runs at a speed of 33MHz. So, the PCI bus has a total bandwidth of 33 x 4, or 132MB/sec. You also have to take into account the number of bits actually transferred per clock signal. With most buses, just a single bit moves over per clock, but AGP 2x does two bits per clock, and AGP 4x actually manages four. So to get the bandwidth of the AGP 4x bus, multiply its width (4 bytes), by its speed (66MHz), by its bits per clock (4), and you get 1056MB/sec. Remember: This bandwidth is divided among all devices sharing the bus—no device has access to all the bandwidth, unless it's the only device on the bus. Therefore, the total amount of data sent from all devices plugged into the PCI bus will never exceed 132MB of data per second.

DOWN TO THE HUB

Intel's Accelerated Hub Architecture manages data flow through two primary hubs. The Graphics and Memory Controller Hub pipes data across several channels between the CPU, the AGP card, and system memory. The I/O Controller Hub manages the connection between the IDE controllers, the USB ports, and the PCI bus. As opposed to the bandwidth limitation inherent in the old northbridge and southbridge architecture, the two hubs are connected via a dedicated, high-speed bus, which no longer shares scarce PCI bandwidth.



Copyrighted material

CPU, this results in a downright insane 8GB/sec data rates across the backside bus.

Memory Bus

Connecting the northbridge to the memory subsystem, the memory bus is another major traffic corridor that can potentially inhibit your system's performance. Generally, the memory bus is kept in lockstep with the system bus to make it easier to hand off data between the two buses. However, some motherboard chipsets are capable of handling memory and system bus speeds that are different, which allows the chipset more flexibility in the memory it can use.

Typical memory bus speeds are 66MHz, 100MHz, and 133MHz. Like the system bus, the memory bus is usually 64 bits wide, so the total bandwidth for a PC100 (100MHz) SDRAM system is 800MB/sec. With PC133 DRAM, you get 1.06GB/sec.

Things are a bit different on memory buses that use RDRAM. Instead of moving large chunks of data over a bunch of parallel wires like a typical memory bus, RDRAM sends smaller pieces, one after the other, at a much faster pace over fewer wires. RDRAM operates over a narrow bus only 16 bits wide, but runs it at 400MHz, double-clocked. This gives PC800 RDRAM a nice 1.6GB/sec of memorybandwidth.

AGP Bus

The increasing complexity of videocards has rendered the PCI bus insufficient to handle those components' bandwidth needs, so Intel developed the Advanced Graphics Port (AGP) bus. The standard AGP bus runs at 66MHz, as opposed to PCI's 33MHz, resulting in a total bandwidth increase over PCI of 132MB/sec to 264MB/sec. With AGP, videocards access memory directly, enabling storage and manipulation of high-resolution textures.

Currently, the AGP 4x bus rules the roost, with a hefty 1.06GB/sec total bandwidth. Where AGP 2x transfers two 32-bit data chunks each 66MHz cycle, effectively doubling the standard AGP transfer rate to 133MHz, AGP 4x moves four 32-bit data chunks per clock cycle, for the equivalent of a 264MHz bus. Sidebanding adds to this scenario by allowing the graphics processor to queue new data requests without stalling the data stream that's currently being read, leading to better bus utilization. The AGP bus is optimized to send data in one direction to a single videocard, so it doesn't suffer from the constant back and forth communication that litters the PCI bus, and it doesn't need to support multiple devices. AGP also allows the graphics card faster access to main memory than that possible through DMA over the PCI bus.

But look! Up in the sky! Arriving mid-2001 in chipsets from Intel, VIA, and AMD, AGP 8x will again double the total graphics bandwidth, for a total of 2.1GB/sec. AGP 8x will only be backwards compatible with AGP 4x mobos, so when you finally get a newfangled videocard that supports AGP 8x, you'll still need to upgrade your motherboard and memory in order to take full advantage of it. Hopefully, by the time AGP 8x arrives, there will be games available that can actually use at least half the available bandwidth.

PCI Bus

The Peripheral Component Interconnect (PCI) bus sustains the final route heading out of the northbridge. It handles the connection to the southbridge, and to all the PCI cards that lurk in your system. But with its 32-bit width and 33MHz speed, the PCI bus' 132MB/sec total bandwidth ensures there's enough room for every card. At the end of the PCI bus lurks the core logic's southbridge. This is where the smaller peripheral buses—such as USB (12MB/sec), IDE (66MB/sec for UDMA/66 drives), and even the lowly ISA—branch out.

While the PCI bus's bandwidth makes for plenty of breathing room in the desktop world, it's not spacious enough to run high-performance servers with multiple hard drives in a RAID configuration. The result is the development of two new PCI-type buses, PCI-X and NGIO; both promise to blow bandwidth wide open.

ISA Bus

The moldy-oldy Industry Standard Architecture (ISA) bus is the dog-ass slowest bus on your motherboard. Running at just 8.3MHz, the 16-bit ISA bus must share its 16.6MB/sec total bandwidth among all devices attached to it. In the past, all cards, including the videocard, were plugged into the ISA bus; now, it's merely a data-starved ghetto. The PC99 specification calls for the retirement of ISA, and that has most power users cheering. There's just one problem: Legacy ports, such as the keyboard and PS/2 mouse ports, are still part of the ISA bus. Future motherboards will still need to provide legacy support for these devices.

Intel Accelerated Hub Architecture

Intel's recent 800 series of core logic chips has redefined the traditional roles of the northbridge and southbridge into two "hubs" connected by a high-speed private bus. The Memory Controller Hub takes the place of the northbridge, and speaks to the system bus, memory bus, and AGP. It also communicates with the I/O control Hub (ICH) over a private 266MB/sec bus. With a width of 8 bits and a speed of 266MHz, the interlink bus boasts a beefy bandwidth of 1,064MB/sec—twice that of the PCI bus. The ICH performs the traditional South Bridge tasks, but drops ISA and adds PCI.

And perhaps best of all, the 810's interlink bus will effectively do away with the ISA bus. Exits are located at the fore and aft of the cabin...

BUS BANDWIDTH

BUS TYPE	WIDTH (BITS)	SPEED (MHz)	TOTAL BANDWIDTH
Backside Bus	64	100-1,000	800MB/sec-8GB/sec
Memory/System Bus at 133MHz	64	133	1.06GB/sec
Memory/System Bus at 100MHz	64	100	800MB/sec
Memory/System Bus at 66MHz	64	66	528MB/sec
Intel "Tehema" System Bus	64	100 (x4)	3.2GB/sec
Intel 820 and 815 Hub Interlink	8	66 (x4)	266MB/sec
AMD Athlon System Bus	64	200	1.6GB/sec
32-bit PCI	32	33	133.3MB/sec
16-bit ISA	16	8.33	16.6MB/sec
8-bit ISA	8	8.33	8.3MB/sec
AGP 8x	32	66 (x8)	2.1GB/sec
AGP 4x	32	66 (x4)	1.06GB/sec
AGP 2x	32	66 (x1)	528MB/sec
AGP 1x	32	66	264MB/sec

Copyrighted material

A Frame in the Life of a Polygon

ONE-SIXTEENTH OF A SECOND DEEP INSIDE A GEFORCE 2

When you play *Quake III*, you're hooked up to a 75Hz strobe of pure adrenaline. With a few flicks of the wrist, you orchestrate a symphony that fuses silicon and your senses. The body count is rising, and your frame rate is pegged.

But pull back the curtain on this silicon wizardry, and you'll see that the magic behind the pixels is almost as interesting as the action on the screen. The newest graphics chips are now just as complex as the CPUs that feed them, and even more crucial to great performance.

An advanced graphics processor, such as nVidia's GeForce 2 GTS, is functionally split in half, and each hemisphere is concerned with a different type of data. The transformation and lighting (T&L) half of the chip concerns itself with the basic building block of all 3D objects: the vertex. Vertices are points identified by X, Y, and Z coordinates in 3D space. Since three vertices combine to define a triangle, it takes thousands of vertices to describe a reasonably detailed 3D world, even though many triangles can share the same vertex. The T&L half of a graphics processor performs millions of mathematical transformations and calculations based upon vertex data per second. Most graphics chips leave this work to the CPU, but the GeForce, and some other next-generation chips armed with geometry acceleration, bravely take on the load.

The second half of a graphics processor concerns itself with pixels. After the vertex data has defined the spans that must be filled in, the pixel pipelines go to work applying and filtering texels from texture maps. The pipelines then combine the texels with myriad other inputs to produce output pixels destined for the screen. While the result is visually stunning, the work behind the scenes is still just a lot of math that's happening really, really fast.

All of this fast math wouldn't amount to much without a sizable amount of fast memory to satisfy the GeForce 2's ravenous appetite for bandwidth. The 32MB of DDR SDRAM found on a typical GeForce 2 is allocated to at least four important regions: two frame buffers, the front buffer and back buffer; a z-buffer; and texture memory.

Frame buffers hold in memory a direct representation of what you see on the screen. A 16-bit frame buffer allows for a 65-thousand color display; a 32-bit frame buffer uses 24 bits for color, yielding a 16-million color output. More color values used to represent a scene means less likelihood of annoying color banding and dithering problems. The extra eight bits in a 32-bit frame buffer are used as an "alpha channel." Game engines rely on rendering algorithms to use these extra bits for transparency-related effects.

The front and back frame buffers are used to smooth the transition between frames. A device called the RAMDAC owns the front frame buffer, grabbing the analog data stored there and converting the digital information into an analog signal out to the monitor. While the front buffer data goes onscreen, output from the pixel pipelines is written to the back frame buffer. When the next frame is ready to go up, the buffers are flipped, and the back seamlessly replaces the front.

The z-buffer must be the same size as the frame buffer, and on the GeForce 2, both must be the same depth—16 or 24 bits deep. As the pixel pipelines draw spans into the back buffer, they calculate the depth (distance from the viewer) for each pixel before they draw it, and compare the calculated value with the Z value already stored. If the new pixel would end up behind a pixel already drawn in that location, it is discarded. If not, the new pixel is drawn, and the z-buffer and frame buffers are updated.

The more bits the z-buffer uses, the greater its precision in depth calculations. A 24-bit z-buffer used with the GeForce 2 is padded out to be 32 bits deep, by the addition of an 8-bit stencil buffer. The stencil buffer serves as a convenient scratch pad that developers can use to implement very realistic shadows and other special effects.

The rest of the onboard RAM is put to use as texture memory. This is where all the texture maps that color your 3D world are stored. Everything from the bricks on the walls to the grin on your enemy's face is stored here as bitmaps. If more textures are needed for a given scene than can fit in available memory, the remainder must be sucked over the AGP bus once every frame, drastically reducing performance. To avoid this, the GeForce 2 supports texture compression, to squeeze more textures into the available space.

To understand what's going on behind the scenes, we'll follow in the footsteps of a texture-mapped box as it goes from the instructions to the graphics engine to a fully-rendered model. The following eight steps trace our box's ride through a GeForce 2, on its way from the CPU to your screen.

While we're showing you all the steps that go into a single frame, bear in mind that the videocard's work is never done; by the time you see one frame, your graphics chip is already hard at work filling the back buffer up with the next. The whole process must be repeated at least 60 times a second to create an appearance of fluid motion.

It's repetitive work, but some chip has got to do it...

—Chris Dunphy

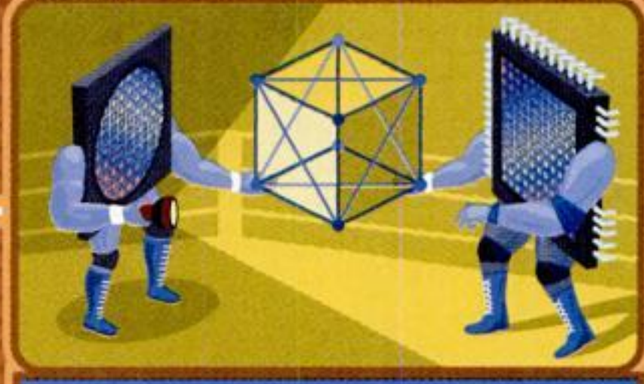
1 Scene Generation

The CPU running Quake III calculates the way our box and the rest of the objects in the scene relate to each other at a particular snapshot in time, according to the mechanics of the game engine. As these relationships are calculated, OpenGL calls send drawing instructions to the graphics driver. The driver takes these instructions, formats them for the GeForce 2, and sends them over the AGP bus for rendering. In English, the relevant instructions might look like this: Draw the box in front of the player that's being lit by a red light from above.

2 Transformation

The next challenge is to transform the multiple 3D models referenced in these instructions, so that they all exist in the same screen space. The GeForce 2 does this by using a dedicated transformation engine to process millions of matrix calculations per second. Those calculations mathematically spin, scale, twist, and rotate a 3D object to the proper screen orientation. The output from the transformation process is a stream of screen-space vertices (points located in 3D space) that define the edges and traits of every polygon that makes up a scene. This is where our 3D model gets shrunk down to fill a few inches of screen space, and planted firmly onto a surface.

3 Lighting



Next, the GeForce 2 turns the lights on. Each model that the CPU delivers to the GeForce 2 can be lit by up to eight hardware-accelerated lights, though most games (including Quake III) still do a lot of their advanced lighting by using "software" techniques such as light-maps. Even in carrying out just these basic light calculations, the GeForce 2's lighting engine helps unload an overworked CPU. The lighting engine uses the color, type (ambient, directional, point, or spotlight), and location of each enabled light to calculate the amount and color of the illumination reaching each vertex. These calculated values are stamped onto the vertices as they flow by. Once the work of the lighting engine is complete, our fully lit box is handed off to the setup engine.

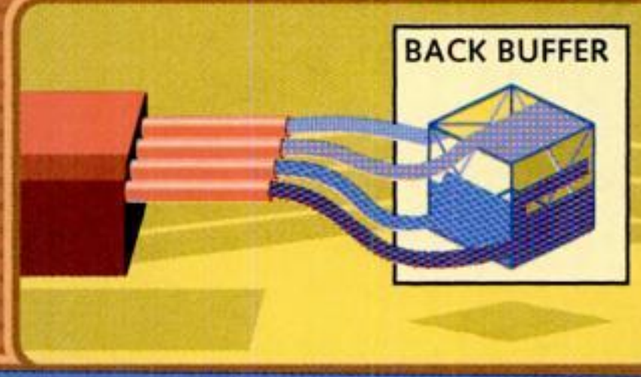
4 Triangle Setup

At this stage, each vertex has a number of properties associated with it, such as its base color, its degree of transparency, and its calculated light color and intensity. The triangle setup engine takes each polygon defined by these vertices and shreds it into strips, called spans. It interpolates the properties defined at the corners of the triangles to calculate the ends of each span. Think of it as putting a triangle through a paper shredder. The shredded hash strips are divided up and fed into the four pixel pipelines. Our model's vertices have now been torn down as far as we can take them. Now begins the task of reassembling him as pixels on the screen.

5 Texturing

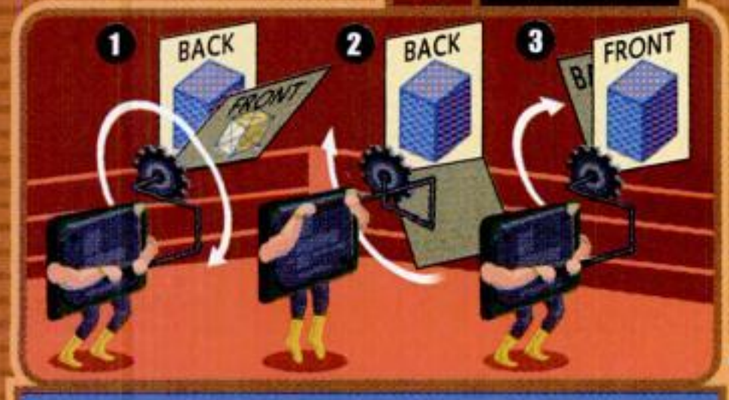
The GeForce 2 has four pixel pipelines. In parallel, they digest the spans provided by the setup engine, processing one pixel at a time. Each of these pipelines contains two texture engines, allowing for very impressive eight-way texturing parallelism. These texture engines are responsible for calculating the texels that fill in the span being processed, but this is rarely as simple as directly grabbing a few chunks straight from a texture map. To achieve a less blocky and more realistic look, advanced filters are applied to average the color of several texels and generate a single output pixel. In addition to the now-familiar bilinear filtering, which requires four texels per pixel, the GeForce 2 supports trilinear filtering (eight texels per pixel), and even 16-tap anisotropic filtering (you guessed it, 16 texels per pixel). Filtering gives the smooth, "3D accelerated" look, and avoids the pixelation of software-rendered games. These texel reads require a massive amount of memory access; fortunately, on-chip texture cache avoids repeated round trips to texture memory.

6 Rendering



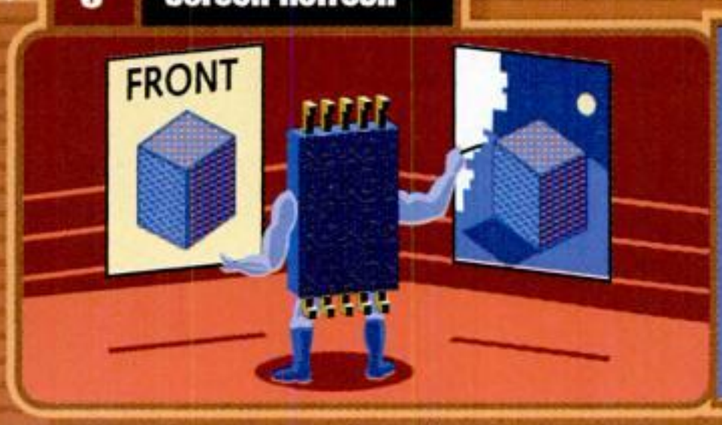
Now that our textures are calculated, it's time for the pixel engine to combine our inputs and generate a final pixel for output to the frame buffer. This stage is very flexible. Depending on the instructions provided by the application, the calculated textures could be combined with the ambient and specular lighting components, a computed fog value, a constant color, or each other, in various complicated ways. The possibilities enabled by this flexible texture-combining architecture go well beyond the now-common multitexture light-map effects. One of the most interesting uses of multiple textures in the GeForce 2 involves using one texture as a "normal map" that, when combined with a base texture, allows for per-pixel lighting and realistic bump mapping. More radical uses of the texture combiner are possible, including even cartoon-style shading. For maximum speed, these operations can be carried out within a single pixel pipeline. For more complicated effects, multiple pixel pipelines work together to generate a single output pixel based upon more than two textures' worth of input. We are now left with up to four calculated pixels per cycle. The final step is to write them to the frame buffer—first performing a z-buffer check and then drawing (or blending, if the pixels are transparent) into the back buffer. At last, our model is on its way to the screen, a pixel at a time.

7 Page Flip



All the spans have been rendered, and our box is sitting in the back buffer waiting to be displayed. The graphics processor now waits for the RAMDAC (RAM Digital to Analog Converter) to pause, then swaps the front and back buffers. The old front buffer is recycled as a new back buffer, and the new front buffer is handed off to the RAMDAC to be drawn to the screen.

8 Screen Refresh



While the rest of the chip begins drawing the next frame into the back buffer, the RAMDAC is busy turning the front buffer into an image on your screen. It reads through the entire buffer one line at a time, 60 to 120 times a second, like a crazed speed-reader on overdrive. Each passthrough pumps an analog signal straight to your monitor, drawing the image that you see. And finally, our trip is done. The frame is drawn. Our box is on the screen. And in a few more frames, it will be history.

when you want to listen to MP3 music – anywhere in your home...

when you want more flexibility than a 200-Disc CD Changer...

when you want your favorite song at the click of a button...

You Want SonicLink !

Turtle Beach
Turtle Beach
www.turtle-beach.com
WIRELESS DIGITAL MUSIC SYSTEM
SONIC LINK
Transmit Digital Music from your PC to anywhere in your home
Digitize and organize your music into custom Playlists
Play your MP3s with a click of the Remote from up to 200 feet away
Listen to hours of uninterrupted music
Listen to Internet broadcasts on your stereo
2.4GHz
AUDIO SENDER/RECEIVER/REMOTE

MP3, WMA, Quick Time...

Digital Music has taken the world by storm! T
Today you've got access to a huge library oc
music via the Internet. Wouldn't it be great
if you could listen to your entire collection
of MP3's in your living room or bedroom?
Now you can - anywhere in your home...
with the Turtle Beach Sonic Link™

Check out our complete line of digital music products, including the award winning Santa Cruz sound card, at www.turtle-beach.com

Turtle Beach

©2000 Voyetra Turtle Beach, Inc. • 5 Odell Plaza, Yonkers NY 10701 • 800.233.9377

www.turtle-beach.com

All rights reserved. Turtle Beach, the Turtle Beach logo, Sonic Link and Santa Cruz are trademarks of Voyetra Turtle Beach, Inc.
All other trademarks are the property of their respective companies and are hereby acknowledged.
Board visual design, prices, package contents and specifications are subject to change without notice.

Copyrighted material

Learn to speak 3D

How much do you benefit from a graphics card that has a complete set of 3D features?

Can a z-buffer cure insomnia? Will you find your way to San Jose with an environment map or a mip map? How much bilinear filtering will make water drinkable? Will excessive bump-mapping lead to hairy palms?

The 3D terminology that graphics-card makers liberally toss around doesn't have to be a foreign dialect. Learn the terms that populate videocard spec sheets, and find out whether features such as anisotropic filtering, multitexturing, and bump-mapping are actually important to you, and which 3D features and effects have the most impact on the Direct3D and OpenGL games you play. Besides being able to spot a visual treat in action, you can leverage your 3D vocabulary to make smart upgrading decisions in the future.

From alpha-blending to z-buffer, here's the lowdown on what each term means and how it looks in a game. We also provide a handy pronunciation guide and show you how to use each word in a sentence, so you can immediately drop hip 3D lingo into your everyday conversations. While others look at a game and say, "Check out the pretty explosions," you'll exclaim, "Dig the kick-ass alpha-blending and particle effects in this multitextured Direct3D gore-fest."

—Sean Downey

texture-mapping: The visage of ball-masher Mark McGwire was mapped over the polygon cranium of a standard model in Baseball 2000.

texture mapping

/TEKS tyur MAP ing/: *Applying a bitmapped image to the surface of a polygon.*

A texture map is a single bitmap image that's applied to the face of a polygon. Texture mapping puts Tiger Woods' face on the polygon golfer on your screen. Just about every 3D game stocking the shelves of your local computer store uses texture mapping, and considering the payoff in detail, it's easy to see why. Getting the same kind of detail from a non-texture-mapped model means cranking up the polygon count, and the resulting heavier geometry requirements will seriously bog down a scene, even with hardware T&L. By supplying details with texture maps, a game can use lower polygon counts, which directly translates into higher framerates.

The big trick with texture mapping is to maintain the proper texture perspective after the image has been mapped onto a surface. Perspective-correction techniques are used in most texture-mapping operations to do away with the depth distortions inherent in applying a 2D image to a 3D object. Perspective correction continuously translates the texels of the mapped image into pixels that match the spatial orientation of the surface, allowing lines to vanish into the distance without kinks or perspective errors.

Texture mapping has been around for awhile, but it still has a few tricks up its sleeve. Imagine the possibilities of mapping video snippets onto polygon surfaces, and you can see where the next texture-mapping innovations are coming from. You'll see more games in the near future that use these advanced techniques.

"In order to hide the damage done to the wall during the party, we texture mapped a nice daisy print over it."

multitexturing

/muhl tie TEKS tuhr ing/: *Applying several texturing effects and blending them to create advanced surface details. Multitexturing mathematically combines textures and effects to produce an output that's richer and more dynamic than a single texture map could ever be.*

Since texture mapping applies a single texture to a surface, it logically follows that multitexturing applies multiple textures to a surface. What doesn't necessarily follow is the versatility that multitexturing lends to the application of texture layers. Not only can it increase surface detail by mapping additional textures over the original texture map, but it can also be used to lay down layers that modify existing textures with bump effects, lightsourcing, per-pixel lighting, algorithmic shaders, and a range of special effects that can recreate the look and texture of nearly any surface. Combining multiple textures in unique ways is the foundation of the shading

Copyrighted material

multitexturing: To achieve its lush details, Bungie's Halo uses four textures mapped to a single surface.

architecture that is cornerstone of DirectX 8.0.

Multitexturing's popularity in the current generation of 3D games is largely due to the big payoff it delivers. Per-vertex lighting effects don't deliver enough precision and detail to justify their intense processing needs; multitexturing allows the effects to be handled by lightmaps, which achieve a totally different look, since light can be calculated at the pixel level, and pre-calculated with much more accurate algorithms. Lightmaps don't suffer the same performance penalties as vertex lighting, since they store pre-rendered lighting effects that can be applied by the engine to the right textures at the right times. Lightmaps are an excellent way for developers to exert complete control over how a texture will look as the light source shining on it changes position.

nVidia's GeForce 2 has four pipelines, each of which can handle two textures at a time. ATI's Radeon has two pipelines, which can process three textures each. Future graphics processors will push this even further.

"Mike's multitextured personality rubs me the wrong way—is he a tool or what?"

bump mapping

/BUMP MAP ing/: *Creating the illusion of variations in surface depth by mapping an additional bump layer to the surface of a texture.*

Bump mapping adds tactile details, such as the dimples on a golf ball, the ridges on a potato chip, or the scratched paint on a bumper, to the surface of a rendered object. Bump-mapped surfaces are especially awesome because they realistically interact with the lighting that falls across them, casting different shadows and reflecting different bumped details that shift according to each light's movement and placement. Largely enabled by multitexturing, bump mapping combines several textures (two for dot-product bump mapping and three for environment-mapped bump mapping) to create the realistic appearance of surface depth.

bump-mapping: Dungeon Keeper's fancy lava effects are courtesy of environment bump-mapping.

Currently, there are two hardware bump-mapping techniques—environment-mapped bump mapping and dot-product bump mapping—and one simulated bump-mapping effect, embossing, that's accomplished through alpha-blending tricks. Embossing doesn't use an actual bump map; instead a duplicate layer of the original surface is shifted to create an alpha channel lightmap containing the shadows and lights of the simulated bumps. This lightmap is blended with the original surface to give the illusion of bumped details. Any card that supports alpha-blending and multitexturing can do embossing.

Both environment-mapped and dot-product bump mapping work their mojo by laying down bump maps, which contain height information for each texel of the surface that's being bumped. Both dot-product and environment-mapped bump mapping calculate lighting on a per pixel basis. Dot-product is generally better looking on matte surfaces, and environmental is better for shiny reflective surfaces. Videologic's PowerVR Series 2, nVidia's GeForce 256 and GeForce 2, ATI's Radeon 256, and 3DLabs' Permedia3 support dot-product bump mapping, and environment-mapped bump mapping can be found on Matrox's G400 and on ATI's new Radeon.

environment mapping: In Expendable, the sky is environment mapped onto the water's surface.

"Edgar sees the dermatologist for his bump-mapped complexion."

environment mapping

/in VIE ruhn ment MAP ing/: *Applying a reflection of the surrounding environment to a 3D object.*

Although a seemingly simple process, well-rendered realtime environment mapping requires a lot of horsepower. The payoffs are accurate reflections and lighting effects that add realism to glass, liquid, and metallic surfaces. Environment mapping entails determining what image is in the "sight line" of a 3D object's reflective surface, reversing the image, and blending it with the texture-mapped surface. This is done by surrounding the 3D object with a projective map that contains a reflected version of what's seen at each point on the object. Then, the reflection and

Copyrighted material

lighting effects are applied on a per-pixel basis to the surface of the 3D object, and constantly updated with new information from the environment map. Depending on the scene being rendered, developers can use dynamic or static environment maps. Dynamic environment maps require recalculating the scene from the perspective of every shiny object; static environment maps are precalculated and require a lot less work, but don't respond to changes in light or the environment.

"The kitchen was so clean, I saw my reflection environment mapped in the floor."

z-buffer

/ZEE BUH fur/: *Area of the local graphics card's memory that tracks the depth position of each pixel in a scene.*

The z-buffer ensures that all the polygons are in their proper places, and that the foreground is in front of the background. Improper z-buffering leads to poke-through anomalies (objects penetrating one another) and flickering (3D objects dropping in and out of existence).

When the models in a 3D scene are fed through the rendering pipeline, the coordinates that place them in 3D space are converted into x and y points that correspond to onscreen pixels. Since displays are 2D-only, the z-values are fed to a z-buffer, which keeps track of the depth of each rendered pixel. The graphic processor compares the z-buffer's depth values with incoming pixels to determine whether they need to be drawn. If a pixel that needs to be rendered lies hidden behind another object, it doesn't make it to your screen, and the graphics processor is saved the trouble of rendering it.

A graphics processor's rendering accuracy depends on how many bits per pixel the z-buffer can handle. A 16-bit z-buffer can handle 65 thousand different depth positions; a 24-bit z-buffer does 16.7 million; and a 32-bit z-buffer can track 4.3 billion possible points in the distance, for the most complex outdoor environments imaginable.

"They met by chance in the z-buffer, and though Paul and Janie developed a deep spatial relationship, she was always in his shadow."

alpha blending

/AL fuh BLEND ing/: *Creating translucent or transparent image layers, and combining them to generate advanced lighting, transparency, and particle effects.*

The "alpha" refers to the alpha bit used to set each pixel's transparency level. Since 32-bit color is actually 24-bits of color data combined with an 8-bit alpha channel, it allows 256 degrees of transparency (or eight alpha layers), as opposed to the two-to-16 degrees of transparency available in 16-bit color's alpha channel. On the whole, blended special effects are greatly enhanced by the extra alpha-channel information, which allows smoother transitions between the alpha layers and the background images. By transitions, we're referring to the way alpha layers are blended together in the frame buffer: The color values of the foreground pixels are combined in the alpha layer with the colors that lie in the background, resulting in the proper transparent effect.

alpha blending: Battlezone II's alpha-blended missile trail and explosion effects cast the familiar glow of violence across alien landscapes.

Alpha blending is used to create effects such as lens flares, transparent water, clouds, and translucent smoke. When it's done properly, alpha blending creates soft fades between the special effect and the background scenery. If you've ever seen the glowing coronas surrounding the bright lights and explosions that populate 3D games, you know what alpha blending looks like.

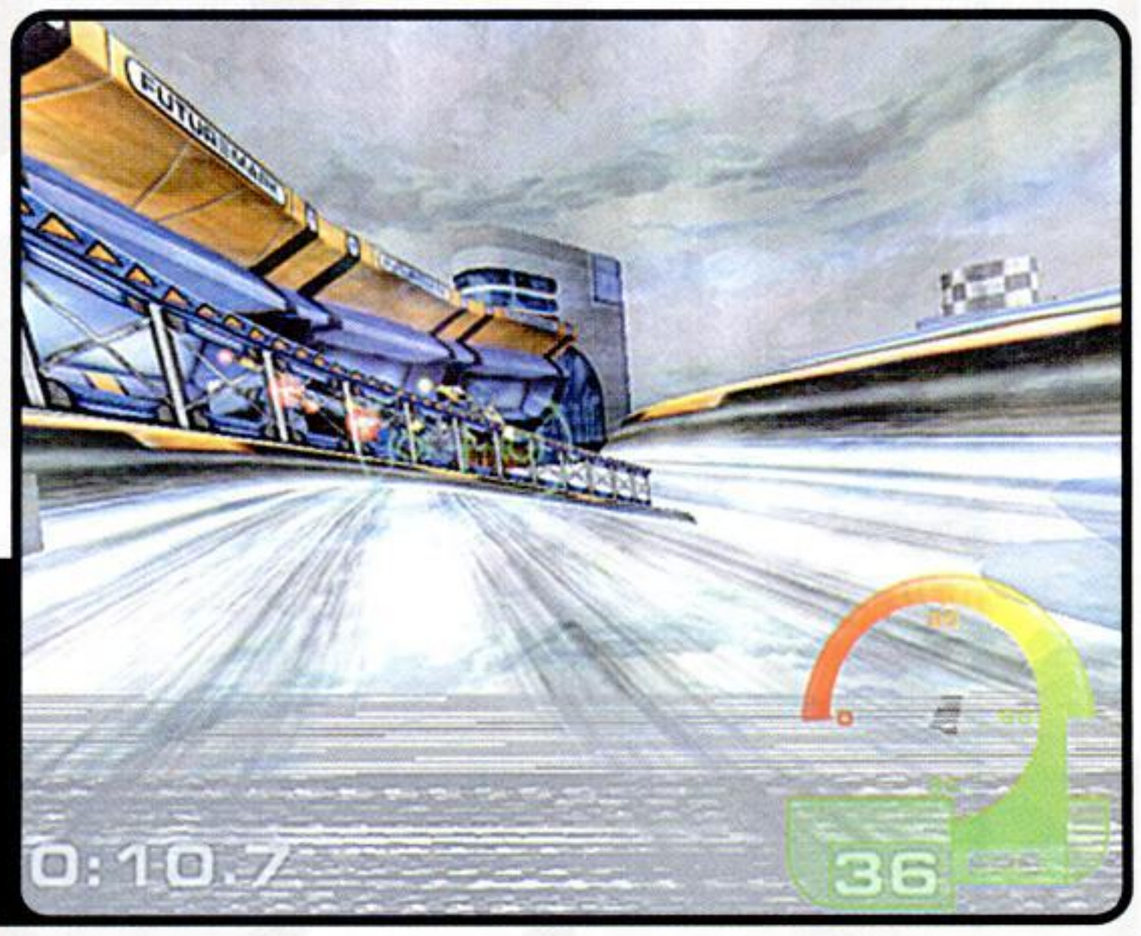
"CG animation and alpha-blended transparencies help little kids to forget that Casper the Friendly Ghost is actually a dead little boy."

fogging

/FAH ging/: *Masking objects in order to give the illusion of distance or add various atmospheric conditions.*

Fogging is a fancy alpha-blending effect that blends the pixels of a translucent fog layer with the objects that lie in the distance. Just like real fog, 3D fogging effects make objects and terrain disappear into a distant haze. While this can be used to simulate fog or smoke, it's also useful for making things seem very far away. The depth information used to blend fogging effects is derived from the z-buffer, which tracks each object's depth within a scene. The further out an object is, the more intense the fogging.

"The students were in a fog by the end of Professor Vogler's lecture, since the topic was completely obscured by linguistic alpha-blending."



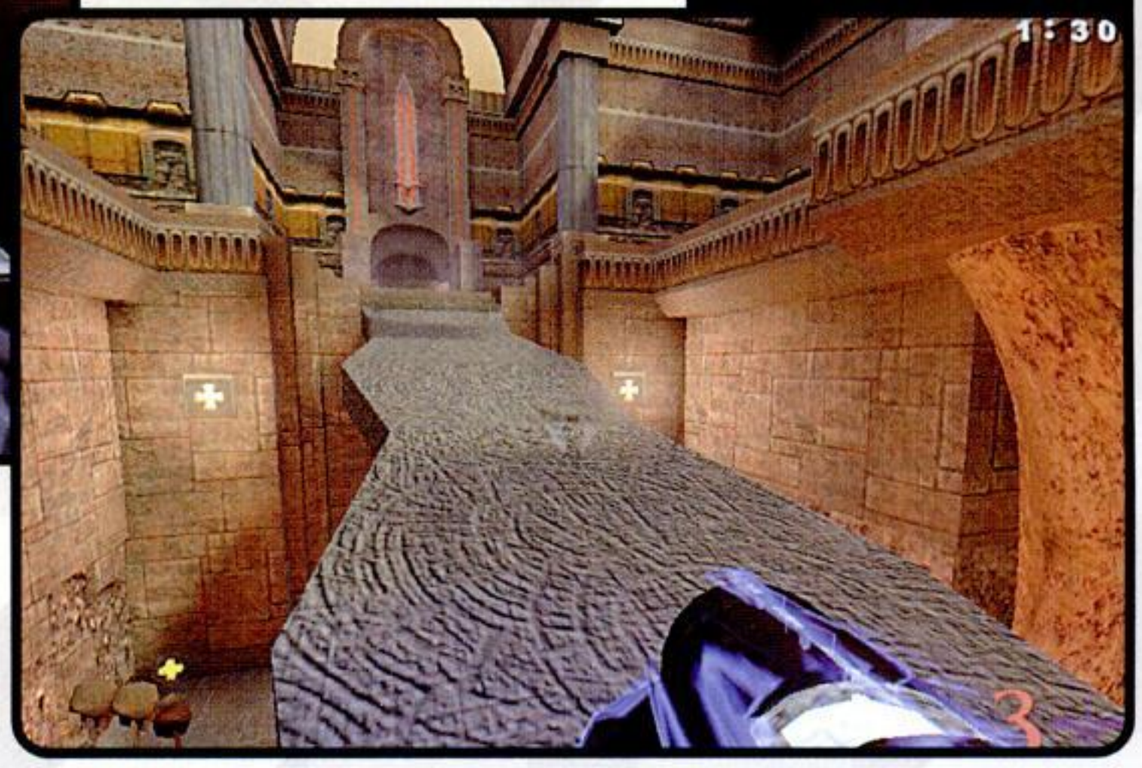
z-buffer: Inadequate z-buffering results in bad visual glitches and image flickering, such as those in this 3DMark 99 Max benchmark.

Copyrighted material

)0+HeliometusMax dies.
3D*Kid falls victim to [AI] Royal's Stormhammer.
SF-PZ/NTTechno connected to the game.
PG-Nameless[MERC catches a Frisbee of Death thrown by [AI] Royal.
000524 5

fogging: Fogging creates the illusion of depth, and can also be used to hide the backside of the clipping plane.

mip-mapping: You can usually spot a bilinear-filtered mip map; in this Quake III shot, it's in the middle of the bridge.



anti-aliasing

/AN tee AY lee uh sing/: *Any process that reduces or smoothes the stair-stepping visual effect that plagues the* ***edges of rendered scenes and bitmaps.***

At some point, all the detailed image data that's chugging down the 3D pipeline must be mashed together and sent out to your screen. The technical term for this mashing process is sampling. Jaggy lines are the byproduct of sampling the huge amounts of data that make up a 3D scene.

To alleviate this problem, several anti-aliasing techniques can be used to increase the sample rate and store more of the original image data. Edge anti-aliasing tracks potentially unsightly polygon edges, then blurs the edges with a filter after the frame is drawn. Full-scene anti-aliasing renders the entire scene at a higher resolution, and then scales it down for output. Edge anti-aliasing requires tricky programming and is rarely used.

Full-scene anti-aliasing can be done in the driver and works for any game, but it requires insane amounts of memory bandwidth, and only the fastest chips have any hope of running FSAA at any decent speed.

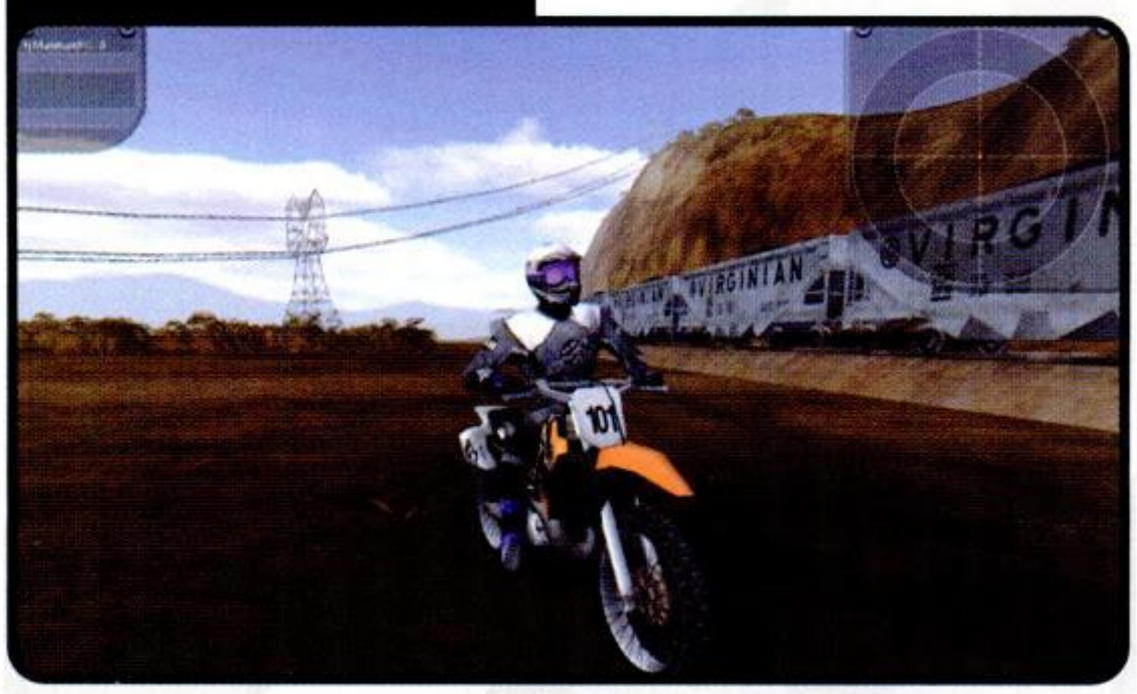
"Lorraine swears by Lancôme's new anti-aliasing lotion; it removes the age spots and jagged lines that weigh down her face."

Mip mapping

/MIP MAP ing/: *Swapping textures of different sizes and details on a single surface as it moves closer* ***or farther away.***

Mip mapping makes objects moving away from you appear in the proper perspective by speeding up rendering and improving the image quality of texture-mapped polygons. It works by taking a high-resolution texture (say, 512x512) and creating multiple copies of it (at 64x64, 32x32, 16x16, 8x8, 4x4, etc...). As the texture-mapped object moves deeper into a scene, the level of detail drops, and lower-resolution texture maps are mapped to the object as it gets smaller and smaller.

anti-aliasing: Full-scene anti-aliasing cleans up the jaggies in games such as Motocross Madness 2.



Without mip maps, the renderer must crunch down the original texture to fit it on the smaller object, which slows framerates and results in aliased textures.

There's rarely a one-to-one correspondence between the texels in a mip map and the pixels mapped to polygons. When a mip map texture is scaled up or down to fit a smaller or larger surface, the resulting image looks blocky and misshapen. To avoid unsightly mapping errors, developers use filtering techniques such as bilinear, trilinear, and anisotropic filtering in the mip-mapping process, to interpolate the final value of each texel based on its surroundings.

Bilinear filtering uses the color values of the four surrounding texels on a single texture map to calculate the final pixel value. The resulting effect is the most visually blurry of the filtering techniques, and does nothing to address the texture shimmering that occurs when one texture replaces another. Trilinear filtering takes care of these visual deficiencies by sampling the four surrounding texels of the two nearest mip maps, resulting in a sharper image that flows more gracefully up and down the detail ladder. However, trilinear filtering requires eight memory reads per pixel, compared to four for bilinear filtering.

Bilinear and trilinear mip mapping don't take into account how a texture can be distorted when it's mapped to a surface that doesn't squarely face the viewer. Angled surfaces elongate pixel details and result in textures that are blurry on one side and sharp on the other. Anisotropic filtering takes samples from even more texels in the surrounding mip maps, but chooses them according to a projection of how the final map will lie. This results in sharper texture details that don't distort as a 3D model rotates.

"In Austin Powers: The Spy Who Shagged Me, Mini-Me is an anisotropically filtered mip map of Dr. Evil."

Copyrighted material

T3: Tomorrow's Technology Today... try the premiere issue

FREE!

T3 is the premiere hi-tech, hi-style magazine for those passionate about the digital lifestyle.

- Each issue is filled with unrivaled coverage of the fast-moving world of consumer electronics
- Blending cutting-edge design and showcase-style photography
- Exclusive news, authoritative reviews and first-class features on all the latest technology

Take advantage of this special offer NOW and be the first to know about the latest, greatest and sexiest consumer electronics.

CALL

877-817-4397

TO RECEIVE YOUR FREE ISSUE AT NO RISK!

If you're pleased with what you see, we'll send you 11 more (12 in all) for only $14.95. *That's a 75% savings off the newsstand rate.*

Offer good in U.S. only. Cover price is $4.99. Canada: U.S. $26. Foreign: U.S. $39.
Prepaid in U.S. funds only. Please allow 6-8 weeks for delivery of first issue.

Copyrighted material

SAMSUNG ELECTRONICS

"A wow factor that leaps off the charts— Get one of these babies and start living the good life."

— Maximum PC

it's a rave

"Some people were born to multitask. It was these folks Samsung had in mind when it designed the SyncMaster™ MP flat-panel monitor."

—Fortune

"Can't decide whether to watch TV or surf the Web? With Samsung's new flat-panel SyncMaster MP, you can do both."

—Time

"The SyncMaster MP from Samsung Electronics is a better approach to convergence."

—Business Week

- 3-in-1 TFT monitor with TV tuner & video inputs
- Resizable PIP
- Remote control

STAY TUNED WITH THE SYNCMASTER MP SERIES

www.thecoolmp.com

SAMSUNG DIGITall everyone's invited™

© 2000 Samsung Electronics America, Inc. SyncMaster is a registered trademark of Samsung Electronics America, Inc.

Copyrighted material

How your monitor works

Seems as though a new CPU or videocard technology rolls out every two months. Maybe losing yourself in the sheer plentitude of a million new silicon circuits is just the right kink to satisfy your high-tech fetish, but don't you sometimes yearn for a simpler life?

We give you the humble computer monitor. Its basic design hasn't changed since the days of punchcards and skinny ties. You can't build a monitor with your 100-in-1 Home Electronics Kit, but the core technology stuffed inside one is more along the lines of Emmett's Fix-It Shop than Xerox PARC.

All traditional computer and television monitors are based on the same Cathode Ray Tube (CRT) technology that was first jimmied together in 1897 by Germany's Ferdinand Braun. The short story is that an electron beam emanating from the back of the tube is coaxed to the front of the tube by a high-voltage, positively-charged electrode; the beam excites a phosphorescent material on the inside of the tube's front face, creating a brief pulse of light.

The longer story requires a tour through the tube itself. We'll start in the back and work forward.

—Jon Phillips

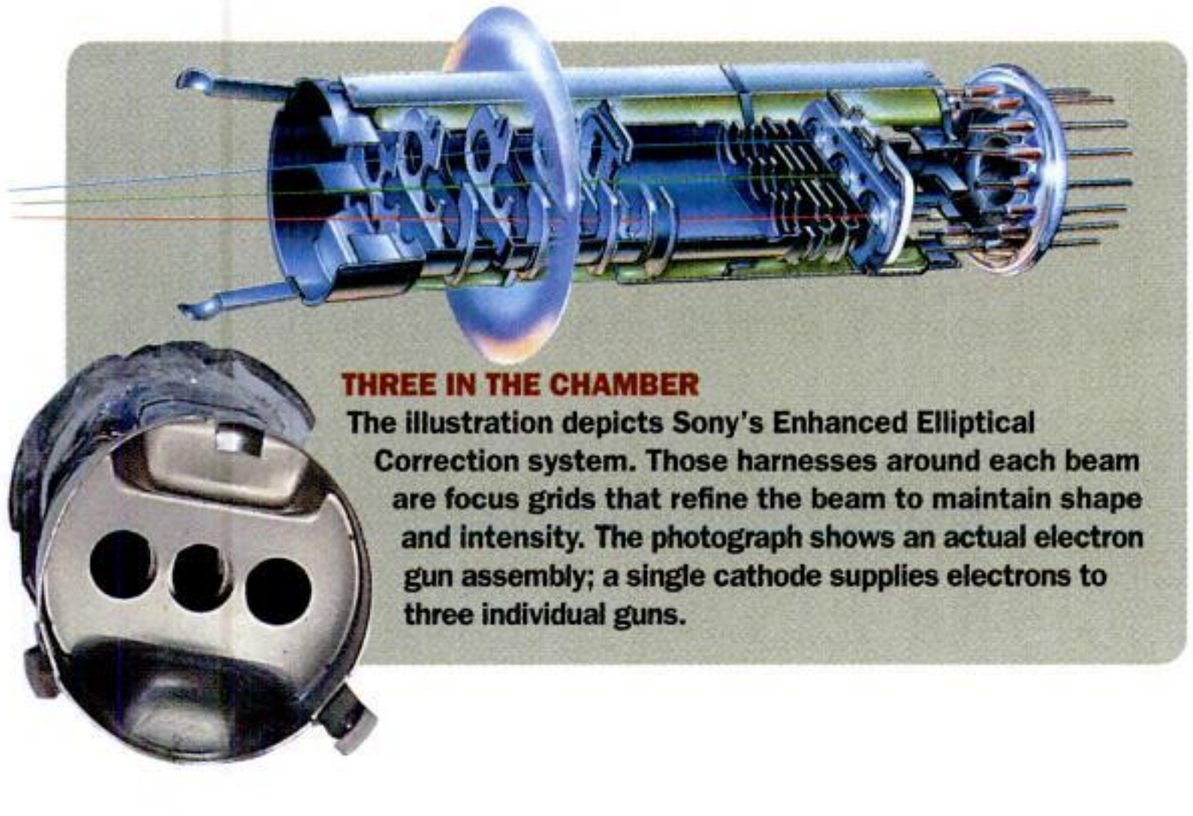
Beam Me Up

The process begins by heating up a cathode, which is a cell that emits electrons (which by definition are negatively charged). An electric current is applied to the cathode, taking it to about 800 degrees Celsius, at which point the cell begins to shed its particles. These loose electrons are gathered by an electron gun, which focuses them into a narrow beam. Color monitors contain three guns, one each for the red, green, and blue (RGB) channels that mix together to form the full rainbow spectrum.

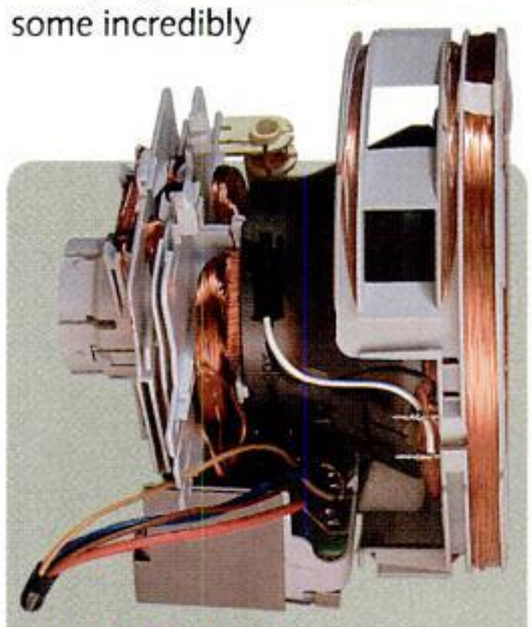
The electron guns sit at the very back of the vacuum-sealed CRT and fire their focused beams through anodes, which accelerate the particles. Anodes generate a strong positive charge that accelerates the negatively charged electron beams towards the front of the monitor. From here, the beams shoot through a deflection yoke located further up the tube's neck. The yoke is defined by four electromagnets placed around the neck in 90-degree intervals. By applying different voltages to each magnet, the yoke can push and pull the beams to any place on the phosphor-coated screen.

In actual practice, the beams follow a very specific path across the screen. They start at the top left-hand corner of the screen and sweep from left to right (at a speed of about 50,000mph), lighting each pixel on the upper-most row of pixels. The beams then return to the right—a process called "horizontal refresh" that is similar to hitting carriage return on a typewriter—and then sweep across the next row of pixels. The process continues, from left to right, top-most row to bottom-most row, until the beams hit the pixel at the extreme bottom right-hand corner of the screen.

Each row of pixels is called a raster. If your display is set to 1280x1024, you have 1024 raster lines, with each line containing 1,280 pixels. Once the beams have made a full sweep of the entire screen—a single refresh, if you will—they return to the left-hand corner of the upper-most raster and start anew. This is called "vertical refresh." If your refresh rate is set to 85Hz, this process reoccurs 85 times each second. It's important to quickly redraw the screen in this manner because each pixel lights up for only a fraction of a second before dimming. By rapidly redrawing the screen, the CRT creates the illusion of a persistent image. Refresh rates below 75Hz can result in an annoying flicker effect, but some incredibly

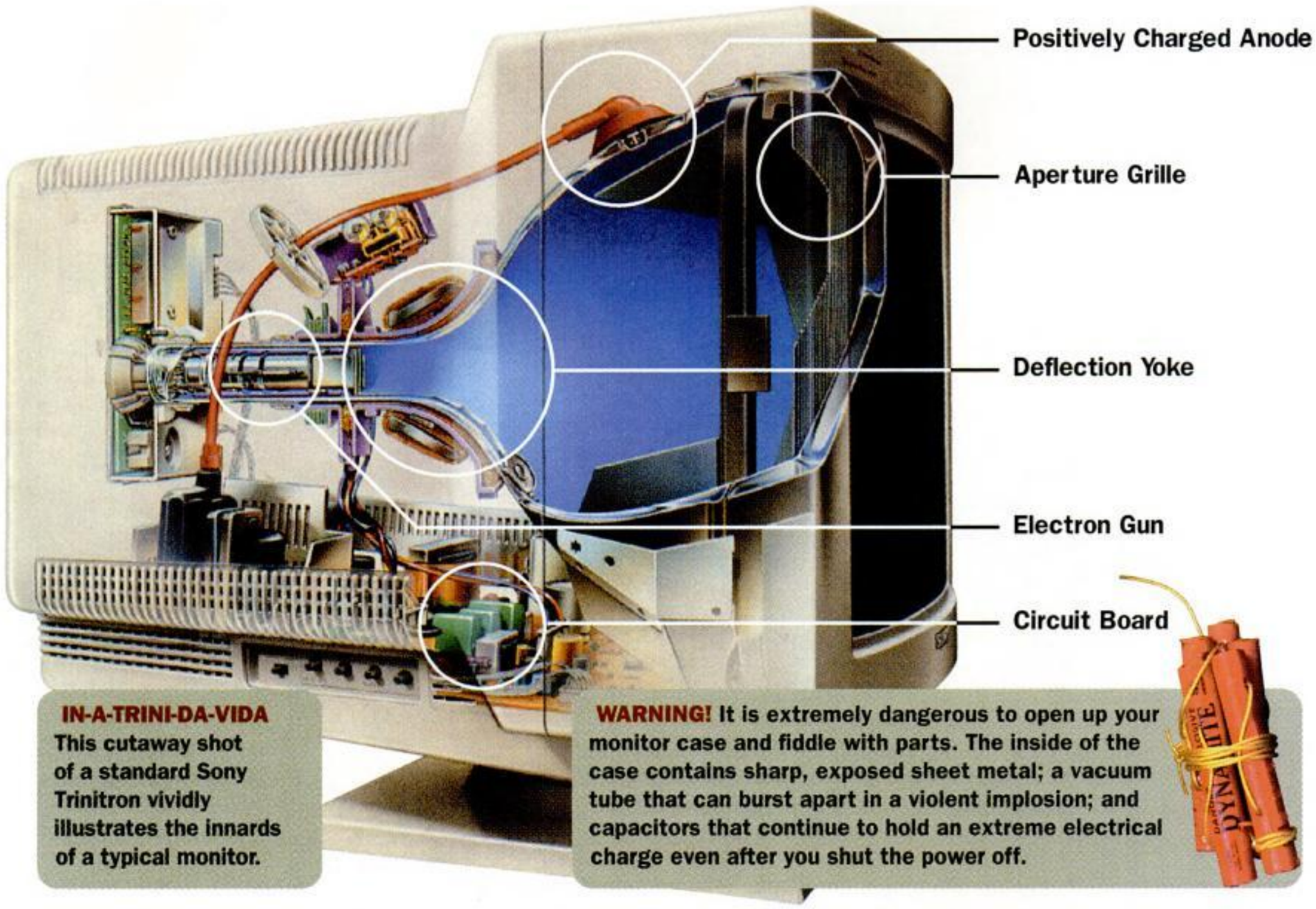


THREE IN THE CHAMBER
The illustration depicts Sony's Enhanced Elliptical Correction system. Those harnesses around each beam are focus grids that refine the beam to maintain shape and intensity. The photograph shows an actual electron gun assembly; a single cathode supplies electrons to three individual guns.



PUSH-ME, PULL-ME
The deflection yoke is the monitor's most complex part. Before shipping, movable thumbwheels are adjusted at the factory for precise convergence. High-end monitors will also allow user adjustments via solid-state circuitry.

Copyrighted material



IN-A-TRINI-DA-VIDA **This cutaway shot of a standard Sony Trinitron vividly illustrates the innards of a typical monitor.**

WARNING! It is extremely dangerous to open up your monitor case and fiddle with parts. The inside of the case contains sharp, exposed sheet metal; a vacuum tube that can burst apart in a violent implosion; and capacitors that continue to hold an extreme electrical charge even after you shut the power off.

perceptive humans can pick up flicker below 85Hz.

Or at least that's what they claim.

Los Tres Amigos

We should note that for most monitors, each individual pixel is actually defined by a triangular trio of phosphor dots—one red, one green, and one blue—that glow brightly when blasted with electrons. By varying the relative intensity of each of the three electron beams as they sweep from pixel to pixel, the CRT can stimulate the corresponding RGB dots differently, for precise color mixing. For example, if pixel X needs to be defined as pure blue, the electron beam assigned to hit blue dots will be powered to full intensity, while the beams assigned to the red and green dots will scale all the way down. If the immediately adjacent pixel Y needs to be defined as a purple tone, the red beam will power up and the blue beam will power down to achieve the right shade.

Before the electron beams hit their corresponding phosphor dots, they're filtered through some type of sieve that confines the electrons to each respective dot trio. This prevents loose electrons from spilling over into adjacent pixels and causing a blurry image. Most monitors use a shadow-mask to perform this function. The mask is essentially a perforated shield that sits directly in front of the phosphor layer, with each perforation corresponding to an individual pixel. Mitsubishi Diamondtron and Sony Trinitron monitors, however, use an RGB phosphor scheme based on uninterrupted vertical stripes. Phosphor-stripe trios are separated from one another by narrow alloy strips; the entire grid of strips is called an aperture grille.

Because the RGB phosphor stripes have no vertical interruptions, as there are in a shadow mask, the sharp edges of the electron beams themselves must define the tops and bottoms of pixels. Whether this introduces fuzziness is debatable, but it does allow more electrons to hit the phosphor layer, which results in a brighter screen.

All About Pitch

The distance between phosphor elements defines a monitor's dot or stripe pitch. This spec, expressed as a fraction of a millimeter, is bandied about by monitor companies to celebrate a CRT's relative sharpness. All things being equal, the closer the phosphors are to each other—that is, the finer the pitch—the sharper your image will be.

When buying a CRT monitor, you have to consider how pitches are actually measured before you get all hot 'n' bothered over who has finer pitch than whom. The standard way to define dot pitch on a shadow-mask monitor is by measuring the distance between the centers of two neighboring phosphor dots of the same color. Because shadow-mask phosphor trios are triangular, this center-to-center measurement is diagonal; the actual horizontal distance between the neighboring same-color dots is usually 0.866 times the dot pitch.

This measurement discrepancy is germane when comparing dot pitches to stripe pitches. The same-color phosphor stripes of aperture-grille monitors are also measured center-to-center, but because the stripes are aligned in rows, and not grouped in triangles, their pitch measurements are naturally horizontal *(see illustrations below)*.

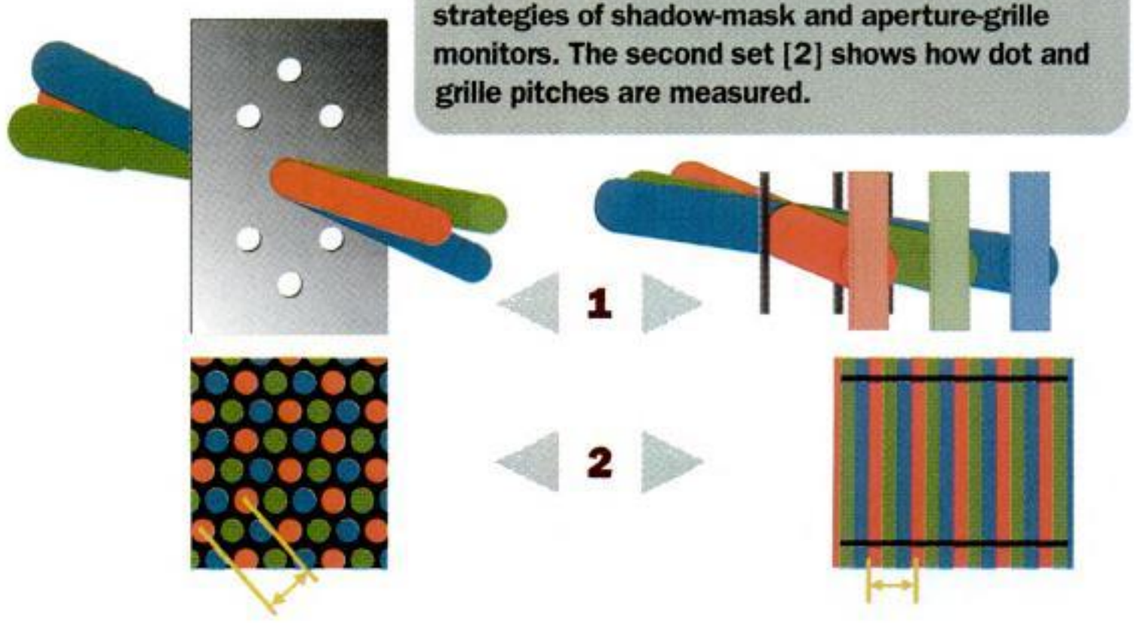
The diagonal arrangement of dot trios has no ill effect on picture sharpness, so it's really only fair to use a common horizontal measurement when comparing advertised dot and grille pitches. To this end, when making dot-to-grille pitch comparisons, you should multiply the dot pitch by 0.866 to give the shadow-mask monitor its fair due. But watch out, since some aperture grill monitor makers do this for you already. Just be sure you aren't looking at "horizontal dot pitch" in the spec sheet before you do your math.

With all that said, is there really much of a difference between, say, pitches of 0.25mm and 0.26mm? We think you'd be hard-pressed to detect a difference during regular gaming, web surfing, or even image editing. Indeed, arguing about a 0.01mm variance is foolish when other factors (such as resolution and convergence, discussed later) affect overall sharpness. In general, though, dot pitch is a useful measurement of monitor quality, since the tighter the dot pitch, the better the construction of the tube.

Most modern dot and stripe pitches fall somewhere between 0.22mm and 0.28mm (at least on the relatively good monitors reviewed by *Maximum PC*). Sony's F500 model was the first to introduce a 0.22mm stripe pitch that greatly improves image clarity when you inspect fine detail up close. And some Hitachi monitors have made the move to a 0.22mm horizontal dot pitch, matching Sony with the sharpest images and smoothest edges available from a CRT.

On the opposite end of the

OF DOT AND STRIPES **The first set of drawings [1] illustrates the different electron-masking strategies of shadow-mask and aperture-grille monitors. The second set [2] shows how dot and grille pitches are measured.**



Copyrighted material

spectrum, you'll find ungodly coarse pitches in standard television sets—but you'll never notice the pitch grain unless you're sitting extremely close to the set. If you're curious to see all of this CRT mojo in action, try getting really close to your TV, where you can see the individual red, green, and blue dots with your naked eye.

Resolution and Refresh

A monitor's phosphor trios, be they dots or stripes, are arranged on a fixed grid. Most 19- and 21-inch monitors boast 1,600 trios across each horizontal raster, with 1,200 trios going down each vertical column. Thus, these monitors are limited to resolve a maximum of 1,920,000 separate pixels (the product of 1,600 and 1,200). Any monitor can scale to smaller resolutions. For example, an object that's six pixels wide at 1600x1200 will be resolved as 12 pixels wide at 800x600. But no monitor can effectively present a resolution that exceeds its logical grid arrangement. Know that many monitors can display a higher resolution signal than they have the pixels on screen to resolve, so you may think you're displaying 1600x1200, when in fact much of the sharpness is being lost. 17-inch monitors are particularly guilty of this. They include the same signal-tuning hardware as their bigger brothers, but not enough pixels to make that tuned signal worthwhile.

Resolution and refresh rate are intimately related: The higher the resolution, the harder it is to keep up a high refresh rate. Remember that a screen refresh is a physical process; the electron guns are sweeping across each pixel many times per second. So when you set your monitor to jump from, say, 1024x768 to 1280x1084, you're asking your hardware to resolve more pixels, and the sweeping process is taxed accordingly. A monitor must therefore have sufficient internal bandwidth to present acceptable, flicker-free refresh rates at high resolutions. Today, top-of-the-line monitors will do 85Hz and higher at 1600x1200, and a crazy 160Hz at 640x480.

What Can Go Wrong

It's a wonder that monitors can present such pristine images, given everything that can go wrong with them. Our two least favorite glitches are misconvergence and geometric distortion.

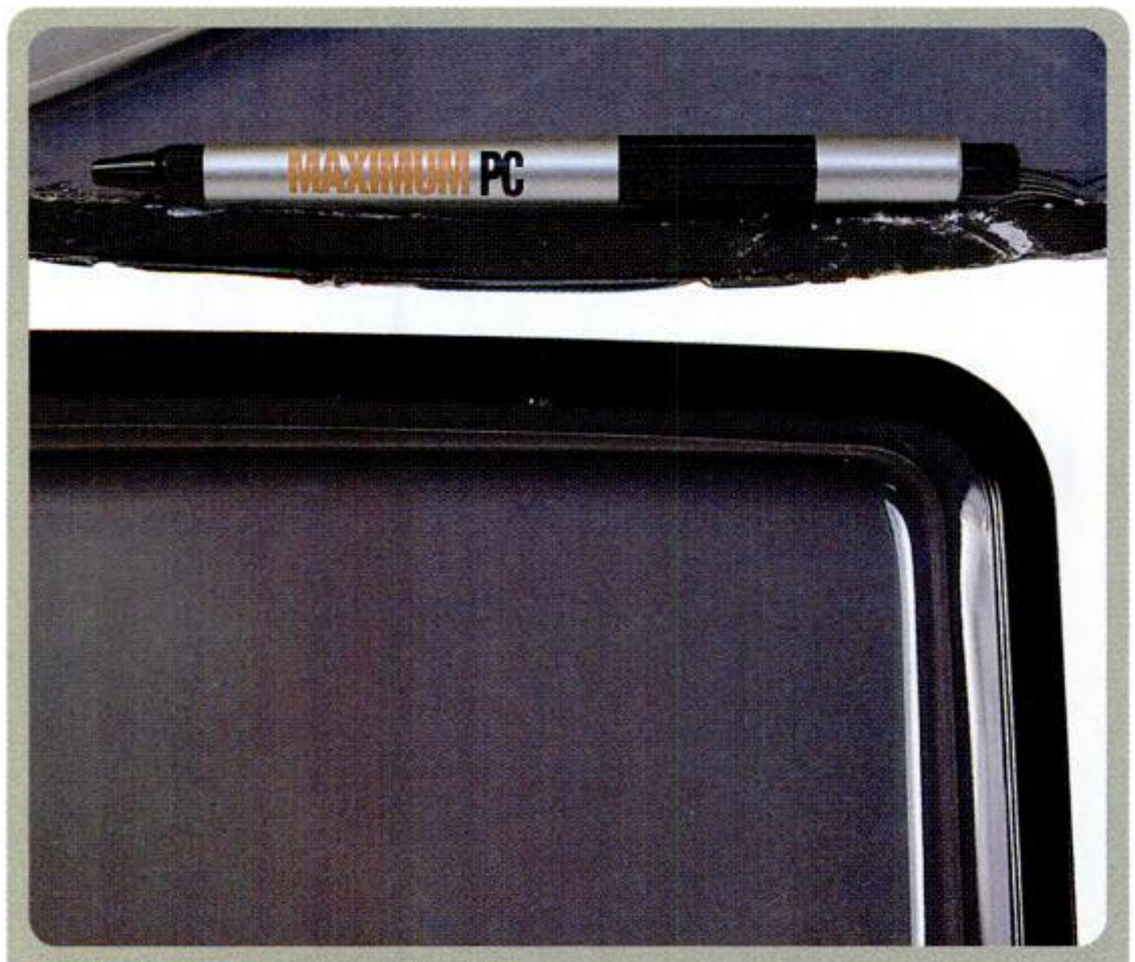
- **Misconvergence:** Color monitors must have their three rapidly moving RGB guns hone in on a single miniscule pixel at exactly the same time. This doesn't always work out as planned. When the RGB beams misconverge, colors don't perfectly superimpose for proper color mixing. In worst-case scenarios, this results in color fringing on the edges of objects.
- **Geometric distortion:** This can manifest itself in any number of ways. For example, perfect circles and squares may appear as ovals and oblong rectangles. Like misconvergence, this particular type of geometric distortion is always worse toward the corners of the screen, due to increased beam deflection angles. It all has to do with the beams traveling different distances at different intensities toward different parts of the screen.

When your beams hit the screen's center-most pixel, they're nailing it straight-on. Let's say this is a 15-inch journey from gun to phosphor. But when the beams have to hit, say, a pixel in the top right, they're striking a glancing blow at maybe 18 inches.

It's much harder to achieve perfect geometry (and convergence) at this angle. You can test this at home with a flashlight: Stand in front of a wall and shine the beam directly in front of you—the beam describes a circle. Now keep the flashlight on its original axis and hit the corner of the wall—the beam describes an oval. Get the point?

Obviously, your onboard circuitry makes adjustments for the more dramatic deflection angles, but it's an imperfect process, and distortion is inevitable.

To better hit the extreme edges of big monitors, your gun should be relatively far away from the phosphor layer—this shortens overall deflection angles and mitigates the need for an inordinate amount of distortion compensation. For this very reason, the new "short-neck" monitors are especially prone to geometric distortion. Same goes for the new "flat-screen" monitors: It helps to have a curved screen when your goal is deflection uniformity across the entire screen.



IT'S THICKERER Betcha didn't think your monitor glass was this pudgy, did you? At about 0.25-inches thick, this Sony glass meets implosion resistance standards.

The Final Word

There are probably more monitor companies in existence than any other type of computer component manufacturer, but not all of them actually make their CRTs. The fact is, a lot of far-eastern manufacturers sell their CRTs to smaller companies that brand them under their own names. Sometimes, these wannabes actually commission CRTs to their own specs, but often, these companies simply slap some plastic over the original manufacturer's base product and call it a day.

If you want to determine who made your monitor's CRT, jot down the FCC "grantee" code on the back of the monitor and enter it into the FCC database at **www.fcc.gov/oet/fccid/**.

You won't find "FerdyCo" anywhere in the database, but you can't say Herr Braun didn't have his chance.

Thanks to Sony and Samsung for providing parts and information for this article. Gun and monitor illustrations by Sony.

KICKED IN THE GRILLE Who knows what heinous fate met this 15-inch Sony aperture grille. Aperture-grille technology, invented by Sony in 1967, fosters a brighter screen and better color uniformity. Still, some people are annoyed by the two barely perceptible horizontal damper wires (not shown in this photo) that keep the vertical grille wires in place.

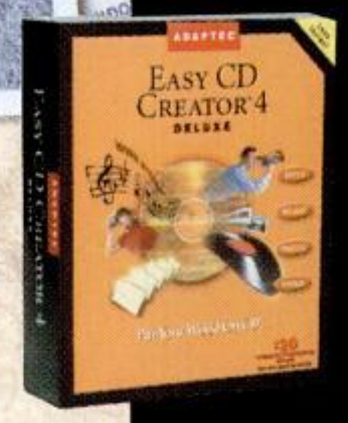
Copyrighted material

CD RECORDING

BEYOND THE ORDINARY

Upgrade to the Deluxe edition of Easy CD Creator™ 4 and greatly expand your CD recording capabilities

The software bundled with your CD-R/W drive has capabilities that are - well, kind of ordinary. But with a simple upgrade, you'll step way beyond everyday CD recording. Record from analog sources like records and cassettes. Download MP3s from the Web. Put photos and videos on CD. And not just record, but enhance them - with your own edits and special effects. You can even use features like Take Two™ to back-up your entire hard disk in 3 easy steps, giving you the tools to quickly recover from crashes or virus infections.



Open up a new world of CD Recording with an upgrade to Easy CD Creator™ 4 Deluxe and finally realize your CD-R's full potential. Available from your local retailer or contact us at 1-800-442-7274.

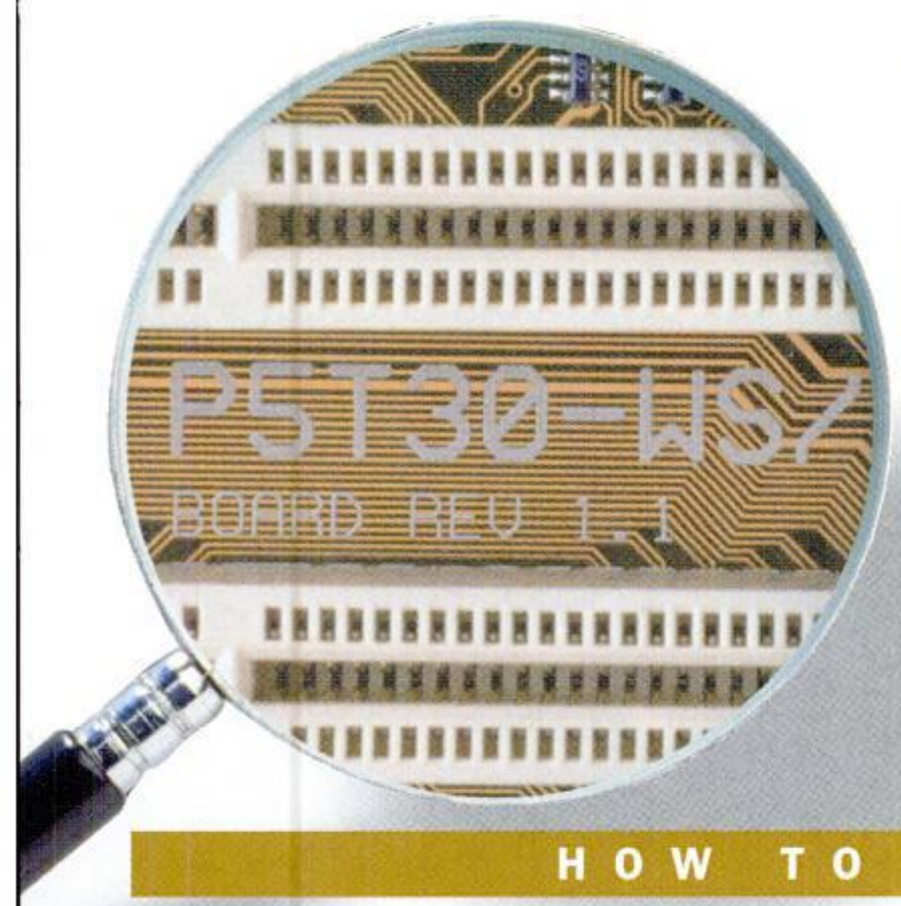
Visit www.adaptec.com/easy3

roxio

performance software from Adaptec®

©2000 Adaptec, Inc. All rights reserved. Adaptec, the Adaptec logo, the Adaptec tagline, Easy CD Creator, and Take Two are trademarks of Adaptec, Inc., which may be registered in some jurisdictions. All other trademarks used are owned by their respective owners. Our software is designed to assist you in reproducing material in which you own the copyright or have permission to copy from the copyright owner.

Copyrighted material



Hardware detective

HOW TO IDENTIFY OLD HARDWARE

This morning, a dusty box of old hardware was unearthed in The Lab. Authorities found the box lying face down in a corner beneath a pile of old joysticks and packing material. None of the moldy hardware appeared to be accompanied by drivers or documentation; some was even devoid of labels indicating a manufacturer's name. Investigators have tentatively labeled the components "junk," and, pending contact from any parties interested in claiming the hardware, plan to quietly discard it in the Dumpster located in the Imagine Media parking lot.

The computer industry is driven by the latest and greatest, but just because a card, motherboard, or memory chip has fallen out of favor with the industry doesn't mean you should leave it for dead. Consider breaking out a flashlight and magnifying glass and playing hardware detective, because to the trained eye, what appears to be a box of worthless hardware can become a heist of useful components. With the handy tips we give you here, you should be able to put a name to almost any legit piece of hardware. Once you have model names and numbers, you can look for system requirements and all the spec info you'll need to rehabilitate and upgrade your hardware booty.

—Gordon Mah Ung

Motherboards

John Doe No. 1 is a no-name Socket 7 motherboard with onboard SCSI. Veteran investigators know that motherboards are among the most difficult devices to identify unless you look in just the right places.

To conduct a proper motherboard autopsy, first remove the mobo from the case. Once you've got the board out, examine it under a good light source for any kind of identifying marks. Lilliputian print on our John Doe No. 1 indicates that it is a Rev 1.1 board that was born in Taiwan. We surmise that the tattoo "P5T30-WS/A4" located between the PCI slots is its model number, but we can't locate a company logo indicating its origin. This is a bad sign in cases where you're hoping to rehabilitate the old board, because without a manufacturer's name, it's almost impossible to get hold of the BIOS updates needed to run the latest processors and correct bug fixes.

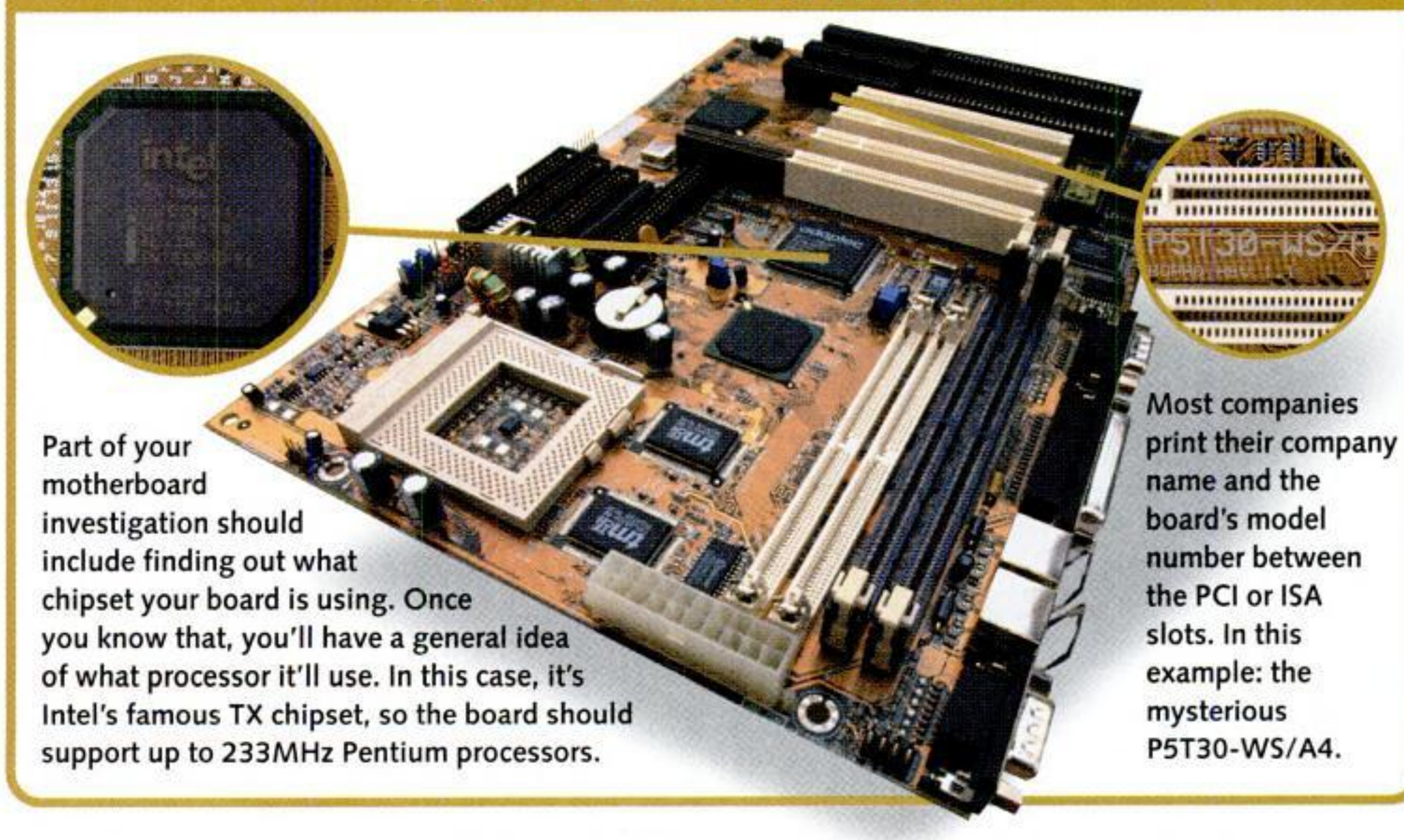
Our investigation turns to the Internet for some serious gumshoe work. We use one of the more powerful search engines, Alta Vista, to search for the numbers we've found on the motherboard.

We did find another number etched into the face of the mobo. Since it resembles an FCC ID, we decided to check the FCC database for the "QEC" number. Usually, FCC IDs use the first three letters and numbers to indicate the company, and the following one-to-14 letters and numbers to indicate the product. Any companies building devices that emit radio frequencies must register with the Federal Communications Commission and receive a unique ID to label their hardware with. You won't find keyboards or mice in the FCC database (unless they're wireless), but you will find hardware such as monitors, soundcards, and motherboards. For equipment made after 1998, try **www.fcc.gov/oet/fccid**. For hardware made before 1998, use **www.fcc.gov/fcc-bin/ead**.

Unfortunately, the FCC database garners us no new leads. We decide to run another web search for the first number found on the board, "P5T30." That search yields several leads. Following a few links leads us to **www.tkramusa.com**. Bingo. The site offers the motherboard's manual, jumper settings, a BIOS update, and information indicating that the board supports Pentiums up to 233MHz, as well as AMD K6 and Cyrix 6x86 procs up to 233MHz.

Remember to try several different iterations when searching for a part's model number. First, search for numbers exactly as they appear on the part. Then, try searching for just

MOTHERBOARDS



Part of your motherboard investigation should include finding out what chipset your board is using. Once you know that, you'll have a general idea of what processor it'll use. In this case, it's Intel's famous TX chipset, so the board should support up to 233MHz Pentium processors.

Most companies print their company name and the board's model number between the PCI or ISA slots. In this example: the mysterious P5T30-WS/A4.

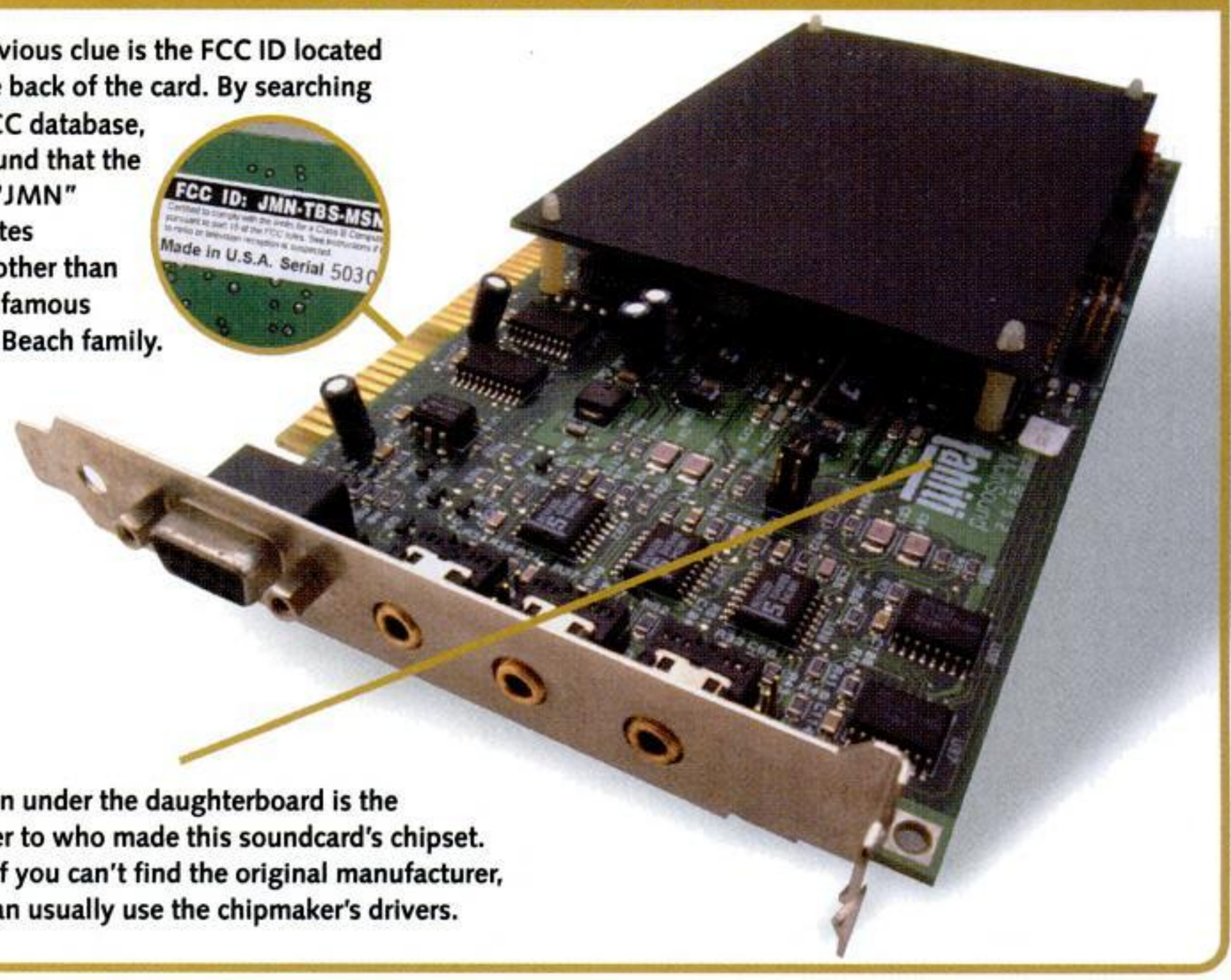
the first few letters, paying careful attention to such things as dashes and spaces. Also search the Usenet, and utilize metasearch agents such as Copernic (**www.copernic.com**) and Dogpile (**www.dogpile.com**), which scour multiple search engines at once.

If your Internet searches come up empty, it's time to examine the board's BIOS boot screen. Like a person's social security number, motherboards are assigned unique numbers that tell you where they were born. You can find these numbers in the BIOS screen.

To boot your board, insert it into a case along with a processor, RAM, and videocard. If the board is AMI BIOS-based, fire it up without a keyboard, or hold down a key while booting; your monitor screen should display a "keyboard error" message, and the boot-up should halt. On the lower left-hand side of the screen, you should see a very long BIOS string, such as "51-0102-001114-00111111-101094-AMIS123-P." Write down the last four digits of the third series of numbers ("1114" in our example). A search for those numbers on AMI's web site (**www.ami.com**) yields the information that the motherboard's manufacturer is Iwill.

For boards with the Award BIOS, hit the "pause" key as the machine is booting, and write down the string of numbers that appears in the lower left-hand side of the screen; the sixth and seventh digits indicate who made board. A full list of manufacturers is located at **www.phoenix.com/pcuser/BIOS/motherboard.htm**.

SOUNDCARDS



An obvious clue is the FCC ID located on the back of the card. By searching the FCC database, we found that the code "JMN" indicates none other than Ithe infamous Turtle Beach family.

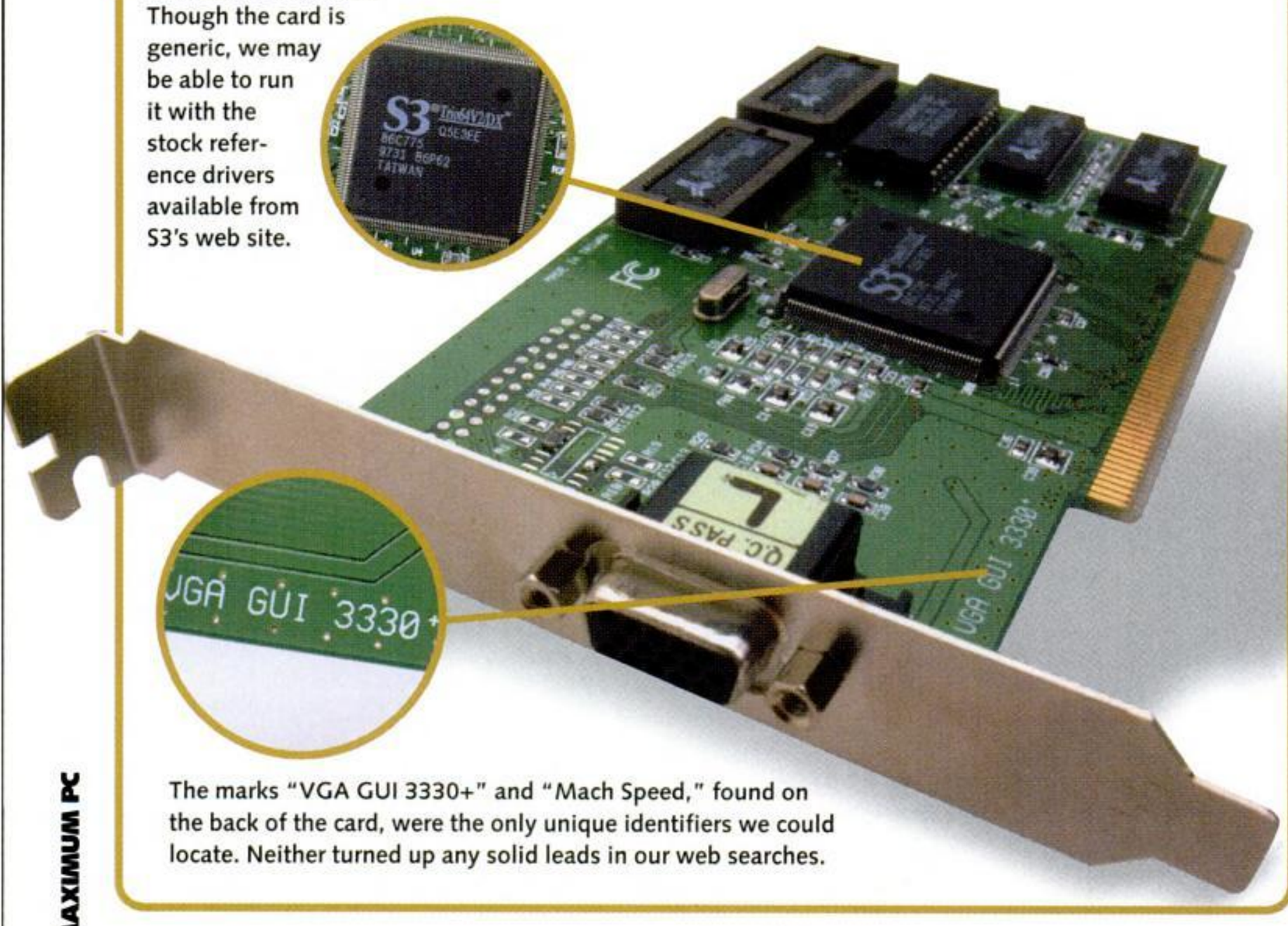
Hidden under the daughterboard is the answer to who made this soundcard's chipset. Even if you can't find the original manufacturer, you can usually use the chipmaker's drivers.

If you've got a Phoenix BIOS, such as those used in the popular Intel mobos, you're out of luck. Phoenix allowed motherboard makers free reign in customizing the BIOS, and no standard identifying string is present.

Once you've figured out who made the board, start searching for that company's web site—a process that's sometimes more difficult than finding out who made the mobo in the first place. Consult the web site motherboards.org, which maintains a healthy list of motherboard makers, and Wim's BIOS page (**www.ping.be/bios/**), which offers a very current list of AMI and Award BIOS ID strings.

If you've exhausted these options, consider posting a message on the Usenet that contains a picture of your John Doe motherboard along with all the information you've gathered so far. Someone may have already done the detective work for you. You can also file a case with the MoboCop feature at motherboards.org. Luckily, the case of our John Doe No.1 has a happy ending. The P5-T30 has begun a new life in an undisclosed area of Southern California.

VIDEOCARDS



The chipset offers most of the information you need. Though the card is generic, we may be able to run it with the stock reference drivers available from S3's web site.

The marks "VGA GUI 3330+" and "Mach Speed," found on the back of the card, were the only unique identifiers we could locate. Neither turned up any solid leads in our web searches.

Videocards

While almost 90 percent of unidentified hardware cases involving videocards are solved, our John Doe No. 2 is a tougher nut to crack. Most graphics cards come from good homes and bear clear identifying marks, but our John Doe board falls into that 10 percent category that have almost no marks—usually because they came from the wrong side of the tracks. No. 2 bears only the marks "Mach Speed" and "VGA GUI 3330+." Our Internet searches turn up a long dead web site.

Our first attempt to solve John Doe No. 2's case involves querying the card with PCIINFO.EXE (available on Miro Wikgren's site, **www.miro.pair.com/pciinfo**), a program that checks for the manufacturer of each PCI card in a system. Unfortunately, this attempt yields more of the same: The report states only that the card is "Mach Speed," and that it was made by S3. If PCIINFO.EXE had returned more info, we could have looked up the videocard on the PCI Special Interests Group's

Copyrighted material

web site (**www.pcisig.com/app/search**).

Our next step is to check the graphics chipset. If your unknown has a heatsink covering the chipset, you'll have to remove it in order to begin your investigation. We found that our victim is based on S3's Trio64/V2/DX chipset. In some cases, that's all the information you need in order to get the latest reference drivers from the chipset manufacturer's web page. But our John Doe needs a BIOS patch, so we're looking for drivers directly from the board's manufacturer, because running the wrong BIOS update on a part is as good as putting a bullet in its head.

Since our card cannot be identified and is probably older than Senator Strom Thurmond, we've opted to retire John Doe No. 2 to the unsolved cases bin.

Soundcards

Soundcards, like videocards, tend to come from higher-class backgrounds; the soundcard industry is smaller and less exotic than the motherboard industry. We took a doughnut break and returned confident that we could crack the case of John Doe No. 3.

Our soundcard example is ISA-based. Distinguishing marks are hidden behind a black-backed daughter card that we could surgically remove but have decided not to, because ample evidence exists elsewhere on the card. A "Tahiti" tattoo tells us it is a known member of the Turtle Beach family. Though we'd seen no bulletin on a missing Tahiti card, we were sure a search for "soundcard" and "Tahiti" would yield results. Then we spotted another clue: an FCC ID, "JMN," on the back of the card. Most older soundcards, and even some newer ones, carry FCC ID numbers.

A search of the FCC database conclusively fingered Turtle Beach as the soundcard's manufacturer. Armed with a positive ID on our card, we visited the Turtle Beach web site to download drivers and documentation. Case closed.

Memory

We didn't expect to identify John Doe No. 4; memory almost always has a checkered past. Hundreds of thousands of unidentified memory sticks are in circulation, and most will never be identified. Our John Doe No. 4 reports that it is simply PC100; we can find no serial number or manufacturer information on the DIMM.

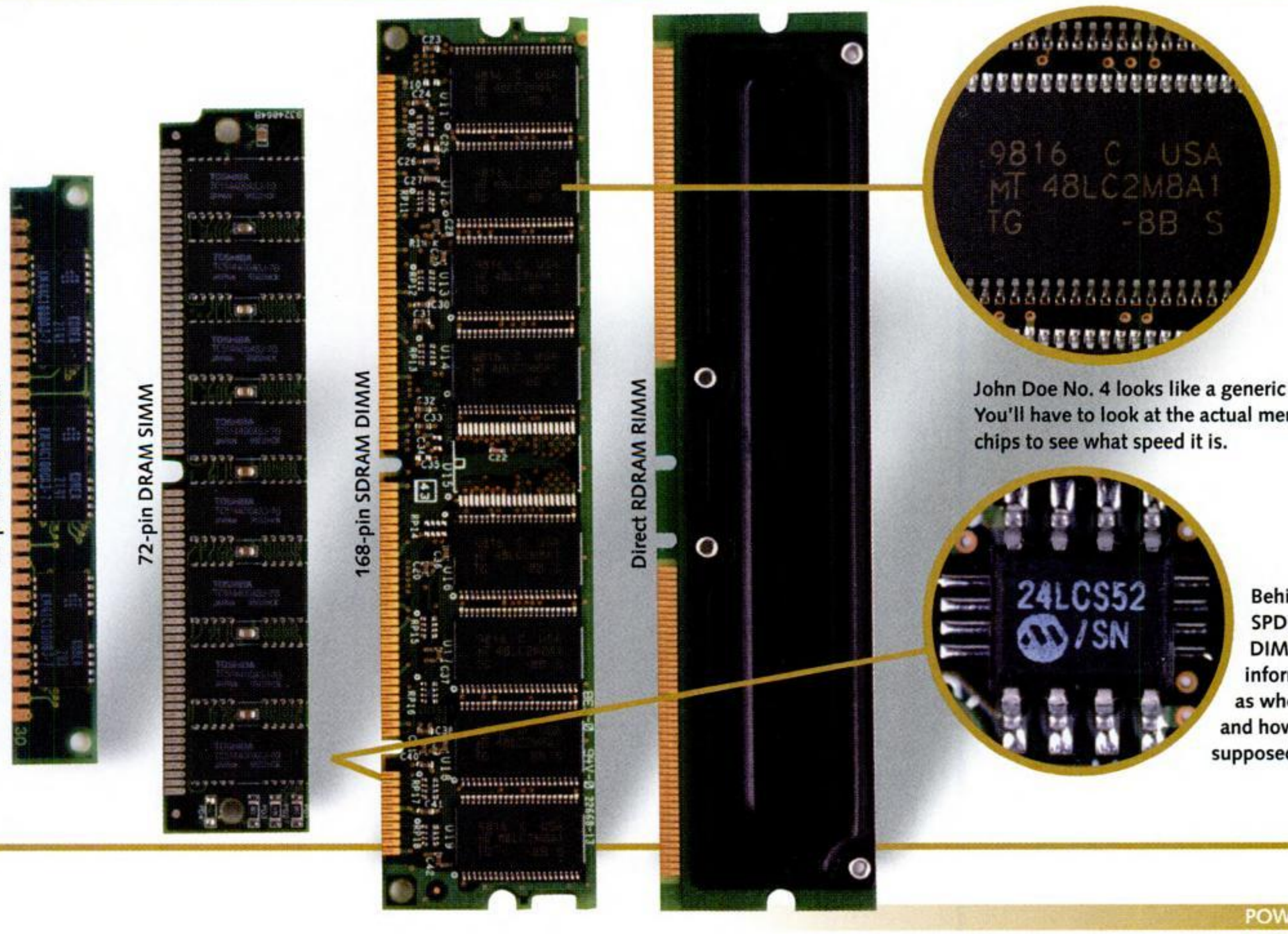
If you're trying to tag an old-school SIMM, you can't go much further than physical inspection. But DIMMs actually have a tiny piece of EEPROM onboard that's often programmed with the identification details you seek. One of the easiest ways to find out who made your DIMM is to use a tool that can read the SPD EEPROM. One such tool is the DOS program DIMM_ID, which will interrogate your memory stick and report back on its size, speed, and serial number, and the name of the memory module manufacturer. Don't rely completely on what it says, though; it works only on Intel chipsets, and some investigators have reported flaky results. For more detailed information extracted from the SPD, the best place to turn is to the excellent system diagnostic tool, SiSoft Sandra 2000 (**www.sisoftware.demo.co.uk/sandra**).

Just be aware that you can't always trust what the DIMM claims to be. Some less-than-reputable DIMM manufacturers don't take the time to properly program the SPD, or worse—they sometimes program incorrect ID data.

To be absolutely certain of what kind of memory you have, conduct a proper autopsy by yanking the module out of the case and examining it carefully. The best you can hope for now is to identify who made the memory chips found on the DIMM. In our case, the chip's "MT" tattoo tells us Micron Technologies made them; the notation "48LC2M8A1-8B" is a part number. Micron's web site (**www.micron.com**) tells us the chips are obsolete, but still true PC100 chips that support 125MHz timing. Net Express maintains a memory guide at **www.tdl.com/~netex/ram/ram.html** that features a list of chip manufacturer codes that can help you take another step closer towards tracking down who made your DRAM.

Who gave birth to John Doe No. 5? We'll never know. But even without the proper credentials, John Doe No. 5 is still contributing to society, working in a PC in Brisbane, California.

MEMORY



John Doe No. 4 looks like a generic module. You'll have to look at the actual memory chips to see what speed it is.

Behind: The SPD chip on DIMMs keeps information such as who made it and how fast it's supposed to run.

Copyrighted material

TOMORROW'S

TECHNOLOGY

TODAY

www.t3magazine.com

T3

www.t3magazine.com

Copyrighted material

Chipset shop talk

Choosing the right motherboard/chipset combo will get you a PC that's powerful now, and upgradable later

It used to be so simple. Just one year ago, picking the core logic chipset for a performance motherboard was a no-brainer—the Intel 440BX chipset was the only game in town worth playing. It was a time-tested performer, long on value and short on bugs.

But Intel's Coppermine and the Athlon processors arrived late last year, armed with new bus speeds and different voltage requirements. Suddenly, the BX didn't quite cut it anymore. Intel's 810 and 820 chipsets have failed to rise to the challenge of becoming the BX's rightful successor, and their short lives have been plagued with compatibility issues and bugs. And now VIA, a longtime Intel competitor, has thrust forward a chipset option that seems to be perfect for the performance-minded, with flavors that speak to the Pentium II and III as well as the Athlon. What's a power-user to do?

Listen to *Maximum PC*, that's what. We'll fill you in on just what a chipset does, and talk you through the strengths and weaknesses of each of the most popular motherboard chipsets currently available.

—Devin Charters

Where the Chips Fall

Your motherboard's chipset is comprised of two chips traditionally called the northbridge and the southbridge.

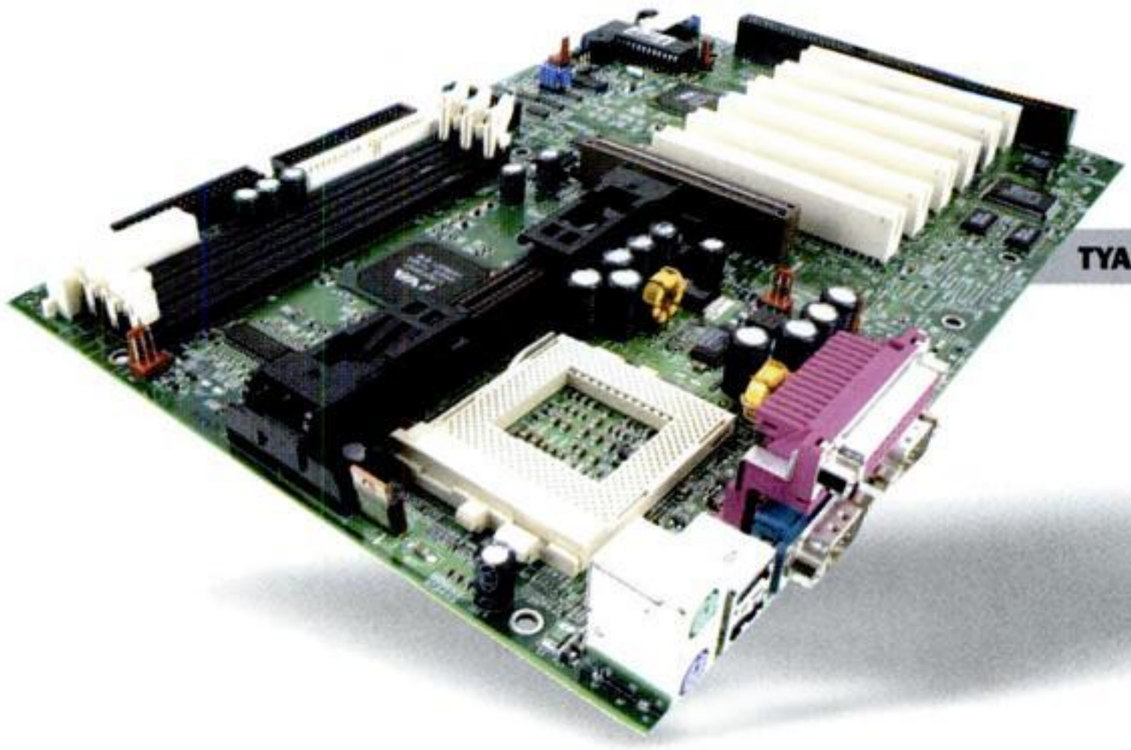
On your motherboard's dataflow map, the northbridge chip serves as the gateway between the CPU and the rest of the system. The northbridge speaks directly to the CPU across the system bus and arbitrates access to the memory, AGP, and PCI buses. Buses are the electrical pathways through which your machine's internal components communicate with one another. A bus' capacity is determined by multiplying its width (measured in bits) by its speed (measured in MHz). The faster and wider the bus is, the more quickly it can shunt data from point A to point B. (See "How Data Moves Around Your Motherboard," on page 63.)

The northie handles tasks that the CPU was never intended to deal with—primarily, moving information around on the motherboard and ensuring it gets from point A to point B. The northbridge spends its day acting as a fast switch between four buses: system, memory, AGP, and PCI. It arbitrates requests and transactions between them, moving data where it needs to go as quickly as possible. The speed and efficiency with which the northbridge intelligently routes data to different buses has a huge impact on overall system performance.

An example of a standard northbridge task is loading data from the hard drive (that's been handed off from the southbridge chip) into system memory, and from system memory into the CPU. It also deals directly with your AGP videocard via the dedicated AGP bus, managing fancy-schmancy tricks such as system-memory texturing, sidebanding, and fast writes. Lest you think that the AGP bus gets preferential treatment, note that PCI slots are also allotted direct access to the northbridge, albeit at a slightly slower speed than the AGP bus.

Only the ISA bus, the redheaded stepchild of peripheral motherboard buses, isn't directly managed by the northbridge—that thankless task falls to the southbridge chip. The southbridge is the dumping ground where all sorts of miscellaneous functions have been integrated, including power management, IDE, USB, and whatever else the core logic decides to throw in, such as integrated audio or Ethernet. In essence, the southbridge sits on the PCI bus and is treated by the northbridge as just another PCI device. While it seems as though the northbridge enjoys the lion's share of the chipset's responsibility, it's in the southbridge that chipset manufacturers have space to innovate and add functions such as onboard Ethernet and 1394 connectivity.

Usually, a chipset's northbridge and southbridge chips spring forth from the same manufacturer. But with the dawning of the Athlon, and the AMD 750 chipset that supports it, motherboards entered a new era of hybridization: The ASUS K7M and FIC SD11 mobos both feature an AMD 751 northbridge working with a VIA 686A southbridge. This works because the southbridge is connected via a PCI bus, so in theory, a northbridge can support a range of different southbridge chips. The era of hybridization will be short lived, though, since chipsets are being designed more and more on the matched pair model as typified by Intel's new hub architecture, which replaces the PCI bus between the chips with a private high-speed interface.



TYAN TRINITY 400

Copyrighted material

Chip by Chip

The data careening around your motherboard buses may be moving at different speeds, but those rates aren't random. The speed of your system bus affects the speed of other buses on the motherboard, and overclocking one bus often overclocks the others. Some chipsets support asynchronous buses that don't tie all the bus speeds together in lockstep. Others, such as the classic BX chipset, force things to fixed ratios, so bumping up the speed of the CPU may allow the memory to run at the same frequency, but the PCI bus will still be limited to a half or a third of that speed. The AGP bus commonly runs at two-thirds the system bus speed. As you peruse the following bounty of chipset options, keep this information in mind.

Chipsets for Intel Processors

Intel 440BX

OFFICIAL SYSTEM BUS SPEEDS:
66MHz, 100MHz

TOTAL MEMORY: 512MB
(running at 66MHz), 1GB registered DIMMS

MAXIMUM CPUs: 2

IDE SUPPORT: ATA/33

AGP SPEEDS: 1x, 2x

The Intel BX chipset is getting a bit long in the tooth, but it remains the chipset of choice for enthusiasts because of its tried-and-true overclockability and rock-solid stability. As the longstanding de-facto chipset for Pentium II/III and Celeron CPUs, the 440BX is exceedingly flexible, and a true tweaker's delight. New BX motherboards have even been designed to support the faster bus speeds and lower voltage requirements of Intel's 1GHz Coppermines, extending the life of this venerable chipset. Though it doesn't support ATA/66 or AGP 4x, and won't "officially" sustain the new 133MHz frontside bus found on some Coppermine CPUs from Intel, the BX chipset still makes a good showing.

Even though the BX will "unofficially" run with a 133MHz system bus, it doesn't mean you should clock it that high, since doing so forces the AGP and PCI buses to run out of spec, which compromises system stability. At 133MHz, the AGP bus runs at 88MHz, which is well over its rated spec of 66MHz. The PCI bus manages a bit better at 44MHz, but this is still 30 percent faster than its rated 33MHz. Be warned—some systems run fine when pushed this fast, and others have been known to get flaky, and even corrupt hard drive data.

Newer BX133 motherboards support a 133MHz bus without overclocking the PCI and AGP buses by using a separate clock for the other buses, but it's probably better to stick with an 815 board if you want to go faster.

Intel 810e

OFFICIAL SYSTEM BUS SPEEDS:
66MHz, 100MHz, 133MHz

TOTAL MEMORY: 512MB
(running at 100MHz)

MAXIMUM CPUs: 1

IDE SUPPORT: ATA/66

AGP SPEEDS: 1x, 2x

Intel's 800-series of core logic introduced a radical change to the relationship between the northbridge and the southbridge—the "Intel hub architecture". While the northbridge chip continues to serve as the gateway to the CPU and memory buses, it's now known as the "graphics and memory controller hub" (GMCH). Control of the PCI bus has moved to the southbridge, which has been renamed the I/O Controller Hub (ICH). But the most important new feature of Intel's new hub architecture is the high-speed private bus that connects the two "hubs" to each other, providing 266MB/sec of bandwidth—twice that of the old PCI connection.

Unfortunately, with this step forward in design, the i810 also took a massive step back, dropping the AGP slot in favor of piss-poor graphics integrated directly into the northbridge. Without dedicated graphics memory, the graphics core steals scarce bandwidth by sharing main memory with the CPU. The only way to upgrade the graphics on an i810 is with a PCI-based videocard. Not a pretty thought. If you care about performance you should avoid the i810 like the plague, especially since the i815 fixes most of these flaws.

Intel 815 / 815e

OFFICIAL SYSTEM BUS SPEEDS:
66MHz, 100MHz, 133MHz

TOTAL MEMORY: 512MB SDRAM
(running at 100 or 133MHz)

MAXIMUM CPUs: 1

IDE SUPPORT: ATA/66 (ATA/100 in the 815e)

AGP SPEEDS: 1x, 2x, 4x

The Intel 815 and 815e make up for most of the sins of the abysmal i810 chipset. The uninspiring integrated graphics are still present, but this time, a fully functional AGP 4x slot makes it onboard, so when you find yourself limited by the integrated AGP 2x graphics, you can upgrade your 815 system with a better videocard. Also new is welcome support for 133MHz SDRAM (without forcing you to overclock the rest of the system to get it). The difference between the two chipsets lies in the southbridge they use: The 815 sticks with the standard ICH and the 815e uses Intel's new ICH2, which adds support for ATA/100 drives, integrated LAN features, and dual internal USB hubs (4 ports).

With the BX getting on in years, the 810 doomed, and the 820 saddled to expensive RDRAM, the i815 is the only chipset in Intel's current lineup that makes any sense.

Intel 820 / 820e

OFFICIAL SYSTEM BUS SPEEDS:
100MHz, 133MHz

TOTAL MEMORY: 1GB RDRAM
(running at 133MHz).

MAXIMUM CPUs: 2

IDE SUPPORT: ATA/66 (ATA/100 in 820e)

AGP SPEEDS: 1x, 2x, 4x

The eleventh-hour discovery of a flaw within the 820 chipset delayed its initial release. When it finally did appear, the 820's support for RDRAM—and the extra costs associated with it—resulted in lackluster sales.

Intel responded by introducing the memory translator hub (MTH), which is designed to convert RDRAM signals to SDRAM and allow the use of standard—and inexpensive—SDRAM on 820 boards. But the MTH brought additional overhead and bugs to the 820 equation, in the form of performance problems and incompatibilities with SDRAM.

Copyrighted material

Intel has recalled all 820 motherboards with SDRAM support, and offered 820 RDRAM boards in exchange.

While Intel's 820e replaces the ICH (south-bridge) with the same new ICH2 found in the 815e (offering ATA/100), it does nothing to fix the busted MTH. As it stands, the high cost of RDRAM makes 820 systems extremely expensive, but if you want dual processors and extra memory support, this chipset is currently your only choice from Intel.

VIA Apollo Pro 133

OFFICIAL SYSTEM BUS SPEEDS:
66MHz, 100MHz, 133MHz

TOTAL MEMORY: 1.5GB SDRAM
(running at 66MHz, 100MHz, or 133MHz)

MAXIMUM CPUs: 1

IDE SUPPORT: ATA/66

AGP SPEEDS: 1x, 2x

As VIA's first chipset to support Intel's Coppermine CPUs, the Apollo Pro 133 extended some noteworthy attributes, such as support for 133MHz SDRAM and ATA/66. However, the chipset's poor overall system performance makes the Intel BX a far better choice. Though the Apollo Pro 133 was among the first chipsets to support a 133MHz system bus speed, memory problems have kept it from mass adoption.

VIA Apollo Pro 133A

OFFICIAL SYSTEM BUS SPEEDS:
66MHz, 100MHz, 133MHz

TOTAL MEMORY: 1.5GB SDRAM

MAXIMUM CPUs: 2

IDE SUPPORT: ATA/66

AGP SPEEDS: 1x, 2x, 4x

Intel's troubles with the 820 chipset have meant happier times for the folks at VIA, who've stolen some of Intel's market share with a revamped version of the 133 chipset. VIA addressed the memory performance problem and added support for AGP 4x, putting the 133A's performance on par with Intel's 440BX chipset, and making the Apollo Pro 133A one of the most attractive chipsets currently on the market. The 133A has made it onto a lot of motherboards, because until the 815 arrived, the 133A was the only way to get AGP 4x and 133MHz SDRAM support without paying for RDRAM.

Chipsets for Athlon processors

VIA Apollo KX133

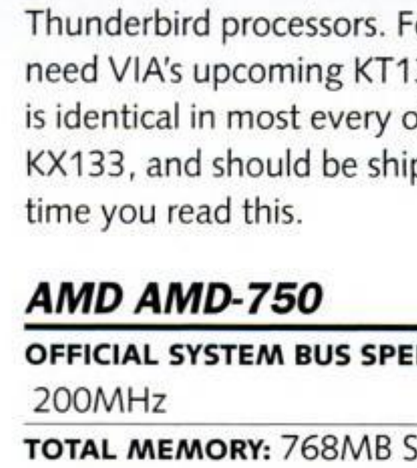
OFFICIAL SYSTEM BUS SPEED:
200MHz

TOTAL MEMORY: 2GB SDRAM
(running at 66MHz, 100MHz, 133MHz)

MAXIMUM CPUs: 1

IDE SUPPORT: ATA/66

AGP SPEEDS: 1x, 2x, 4x



The long-awaited KX133 is the first VIA chipset to support AMD's Athlon. With support for a 133MHz memory bus, the KX133 offers a big performance increase over AMD's own 750 chipset, which locks the bus at 100MHz. The KX133's AGP 4x support won't yield much of a performance difference right now, but it will mean a big gain in future games.

The only roadblock to the KX133's future success is its incompatibility with AMD's Thunderbird processors. For that, you'll need VIA's upcoming KT133 chipset, which is identical in most every other way to the KX133, and should be shipping by the time you read this.

AMD AMD-750

OFFICIAL SYSTEM BUS SPEED:
200MHz

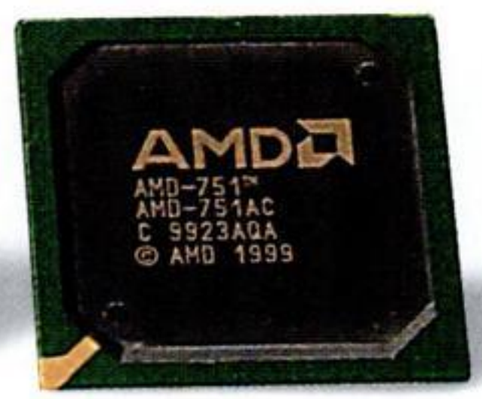
TOTAL MEMORY: 768MB SDRAM
(running at 100MHz)

MAXIMUM CPUs: 1

IDE SUPPORT: ATA/66

AGP SPEEDS: 1x, 2x

The chipset AMD created to support its own Athlon CPUs was impressive when it initially launched, but its success was short-lived. Without support for AGP 4x and PC133 SDRAM, and with memory topping out at 768MB, it's doubtful that this chipset will remain competitive in the current marketplace. The AMD 750 is far from washed up, though. The chipset still remains useful due to its compatibility with AMD's Thunderbird Athlon, but with the VIA KT133 and AMD's own 760, the 750 doesn't have much going for it.



Chips on the Rise

Intel 850: Intel has a brand new chipset in the works to go along with the upcoming Pentium 4. The 850 "Tehama" chipset will feature a 400MHz data rate system bus that matches the bandwidth of the system bus exactly with that of a dual channel Direct RDRAM at 3.2GB/sec. The chipset should have dual-proc support out the gate.

Since Intel has recently relented on its position for Direct RDRAM-only chipsets, the company should have a chipset in the first half of 2001 that supports PC133 SDRAM, and hopefully a follow-up that supports DDR-SDRAM.

AMD 760: With the 760, AMD should regain its title as performance leader in Athlon chipsets. The major changes here will be support for AGP 4x and for DDR-SDRAM, which can transfer data on the rising and falling edges of the clock, resulting in twice the bandwidth of PC133 memory. This chipset is due in late 2000 or early 2001.

AMD 760MP: As if 760's DDR-SDRAM support wasn't cool enough, AMD's 760MP chipset should offer the same features that the 760 has, with one major addition: dual-processor support. It's two, two, two procs at once—and there just can't be anything bad about that. At last, the Athlon will have something to throw against SMP Intel systems.

VIA KT133: VIA's KT133 should address the problems that make its KX133 chipset incompatible with AMD's Thunderbird Athlon. Slated for release this summer, the KT133 will ship solely in Socket A flavor, and will sustain AGP 4x, PC133 SDRAM, and improved support for ATA/66.

VIA Apollo Pro 266: VIA is expected to offer DDR memory support with its Apollo Pro 266. With AGP 4x and ATA/100 in the south-bridge, the Apollo Pro 2000 will give Intel's 820e a run for its money.

VIA KX266: With its KX266 chipset closely following the Apollo Pro 266, VIA is out to show that it's as big a supporter of AMD silicon as it is of Intel's. VIA will serve up seconds with its new Athlon chipset, but they won't be sloppy. The feature set is expected to be on par with the Apollo Pro 2000 with AGP 4x, ATA/100, and PC2100 DDR support.

MICRON SAMURAI: Micron has delivered some pretty impressive server chipsets in the distant past, and now they're working on a mainstream part to show off the power of DDR. It should be fast, and from what we hear, there will be a version of the Samurai with integrated graphics—all that's left of Rendition's long AWOL V3000 and V4000 graphics processors. Both AMD and Intel flavors of the Samurai will be offered. No release dates have been announced.

Copyrighted material

Don't miss the ultimate resource guide for PC music and audio from **MaximumPC**.

SPECIAL ONE-TIME ISSUE

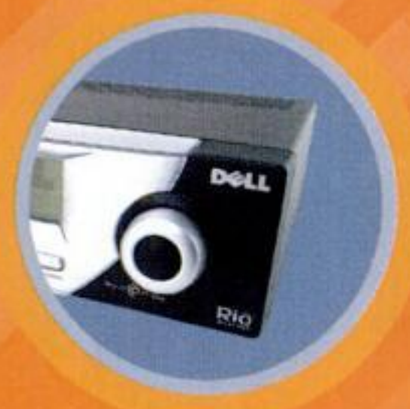
MAXIMUM PC

Your **Minimum BS** magazine presents:

MUSIC AND AUDIO

- Music creation and recording how-tos
- Extensive audio software and hardware reviews
- Top MP3 player roundup
- Top 50 sites to download music
- CD-ROM with free programs and more

Available only on newsstands November 14, 2000 through February 14, 2001 at Barnes & Noble, B. Dalton, Borders, CompuUSA, Waldenbooks and many other retailers near you.



Copyrighted material

RAM-o-Rama!

Extra memory never hurt, but not all bytes are created equal. New memory technologies can be integral to the performance of a new CPU architecture, and a different flavor of RAM can turn an average graphics card into a screamer. A thorough understanding of memory is essential if you want to make smart upgrading decisions, so here's what you need to know.

—Chris Dunphy

Feed the starving

At one time, CPU and memory speeds ran neck-and-neck, but once CPUs crossed the 66MHz barrier, they left memory in the dust. Bus multipliers such as 1.5x, 3.0x, and 4.5x describe not only how fast new CPUs run, but also how many times processor development has lapped memory speeds. Currently, the fastest CPUs are running up to 8x faster than the main memory on which they rely for data nourishment. It's little wonder that modern CPUs are starving for more data to process.

Ideally, your processor would be served by infinite amounts of infinitely fast memory. Unfortunately, this proves to be infinitely expensive. To balance the three-way tradeoff among price, quantity, and speed, system architects have taken a multi-tiered approach. They begin with a tiny amount of extremely fast and expensive memory in the heart of the CPU, add a larger amount of slower and less expensive memory as L1 cache, and keep going in this direction until they reach the amazingly cheap and astoundingly slow "virtual memory" stored on your hard drive.

Deep inside your CPU lurks the fastest memory of all: your processor's registers. A typical CPU has only a few dozen of these beasts, and each one is able to store just a single value. These registers are directly wired into the brain of your CPU, and only data stored in the registers can be manipulated at the CPU's maximum raw speed. Whenever the CPU needs to crunch a number that's not already in a register, a memory request is generated and the CPU's internal memory controller goes to work. This is when things get interesting.

Modern CPUs support out-of-order execution, and often have multiple internal execution pipelines, so the CPU can get some work done while it waits for incoming fodder. But if the memory controller can't quickly find the bits that the CPU needs, the processor grinds to a halt with nothing left to do. Fortunately, the memory controller rarely has to tap "slow" main memory to find the fodder the CPU needs. For this, you can thank the miracle of PC architecture known as cache.

Cache me if you can

All modern CPUs try to crunch a constant stream of instructions by throwing some Level One (L1) cache into the mix. The L1 cache is generally a tiny amount of static RAM (SRAM) physically integrated into the CPU silicon itself; it runs at the same speed as the CPU. Data can be moved from L1 cache into a register in as little as one tick of the CPU's clock, hardly slowing things down at all. But because the L1 cache is so closely tied to the CPU registers, it's very expensive and there isn't room for very much of it. So, rather than give up and wait for main memory, the memory controller turns to Level 2 (L2) cache.

L2 cache is made of the same expensive SRAM as the L1, but because it's not so tightly wired to the brains of the CPU, it's cheap enough to use more of it. In older systems, the L2 cache sat on the same slow external bus as the main memory (remember cache sticks?). This external cache could answer data requests much faster than main memory could, but was severely limited by the shared system bus. This was fine in the days of 200MHz processors on 66MHz busses, but proved just too damn slow for anything faster.

To solve this, the Pentium Pro introduced the concept of a separate cache bus. This separate bus segregated the cache from main memory, and allowed the fast SRAM L2 cache to talk to the CPU at one speed while the slower system bus ran at another. The Pentium II, P-III, and Athlon all provide a sizable 512K of L2 cache running at half the processor's core speed, which is still much faster than main memory.

By the time the Celeron rolled around, Intel had perfected its manufacturing to the point that it could squeeze L2 cache on the processor die itself, ditching the expensive cartridge and external SRAM. The downside was that the Celerons only managed 128K of L2 cache. But since this cache was now internal, it could run at the full CPU clock speed, rather than half the speed. The latest Coppermine-based P-IIIs and Thunderbird Athlons have gone this same route—dropping down from 512K of external, half-speed L2 cache to 256K of internal, full-speed SRAM-lovin. In all but the heftiest server benchmarks, the trade has proven worthwhile.

Dynamic Delights

The CPU's memory controller does its best to keep copies of necessary data stored somewhere in the cache hierarchy, but at some point, a "cache miss" is bound to occur and the CPU will have to turn to main memory to replenish itself. Main memory isn't nearly as fast to access as cache, but it's

The blue metal shield on this Rambus module acts as a heatsink and RF shield.

Copyrighted material

certainly a winner in terms of price. Thanks to the proliferation of cheap dynamic RAM (DRAM), PCs with 128MB or more of main memory are now practical and affordable. The basic DRAM cell that serves as the foundation for all main memory technologies is, in essence, nothing more than a tiny battery. DRAM consumes a lot less power than SRAM, and, thanks to its small size, is dramatically cheaper to manufacture. But maintaining a charge in a DRAM cell requires continual refreshing, and reading and writing data (by charging or discharging the "battery") is inherently slower than with the solid-state, all transistor SRAM. Typical word processing and web surfing can be handled with ease by any main memory system, but a new generation of multimedia is blowing away even the best cache schemes, so main memory performance suddenly matters more than ever. As a result, new technologies have emerged to satisfy your starving CPU's cries for bandwidth.

The current king of the memory hill is SDRAM. In its 66MHz and 100MHz flavors, SDRAM is found in the majority of mainstream PCs made today. Also known as Synchronous Dynamic Random Access Memory, SDRAM has completely pushed aside the former memories of choice—EDO and FPM—because it's built to handle a faster bus and complement highly clocked CPUs. Older EDO and FPM DRAM are non-synchronous, which means that the memory chips aren't tied to the speed of the system bus. But for roughly the same cost as older memory, SDRAM offers synchronized timing, and can easily run at 100MHz and beyond. Because older DRAM designs didn't have much headroom beyond 66MHz, SDRAM has ruled the roost for the last two years. Beyond SDRAM, the next step in the evolution of main memory isn't nearly so obvious.

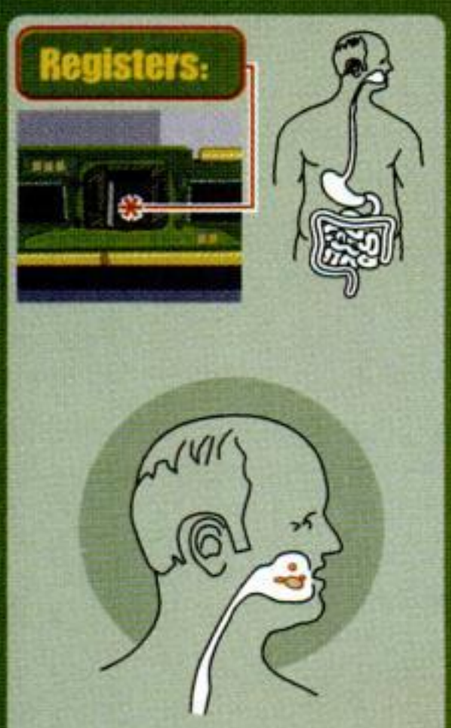
PC133 SDRAM

PC133 SDRAM is nothing fancy; just the same tried-and-true SDRAM clocked to 133MHz. It's only officially supported by Intel's 810 and 815, and VIA's Apollo Pro 133A, but unofficially, PC133 has become the BX motherboard overclocker's best friend. PC133

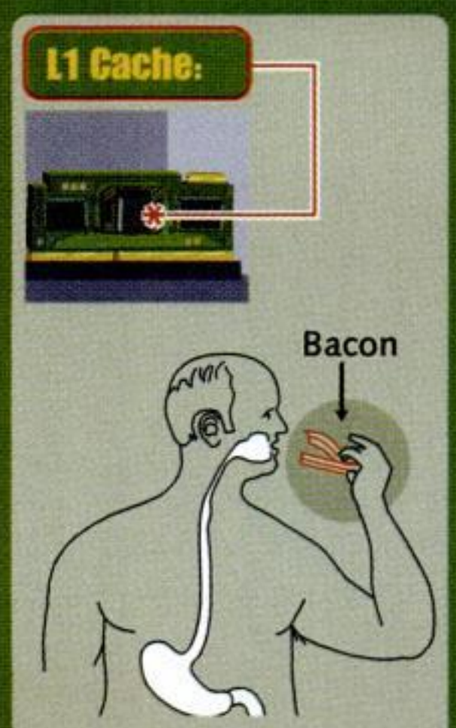
The PC100 DIMM on the left is the most common memory currently in use, but watch for more exotic memory technologies, such as the VC133 on the right, to replace it.

Feeding a Hungry CPU

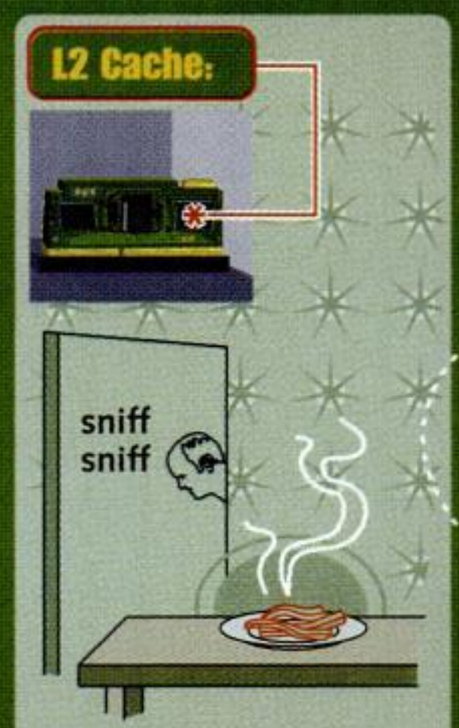
Your CPU has a high metabolism. It's always hungry for more data to process, which is why so much of your system is devoted to keeping it fed. You can think of the different memory levels that service your CPU in terms of how far away the potential nourishment is from the processor.



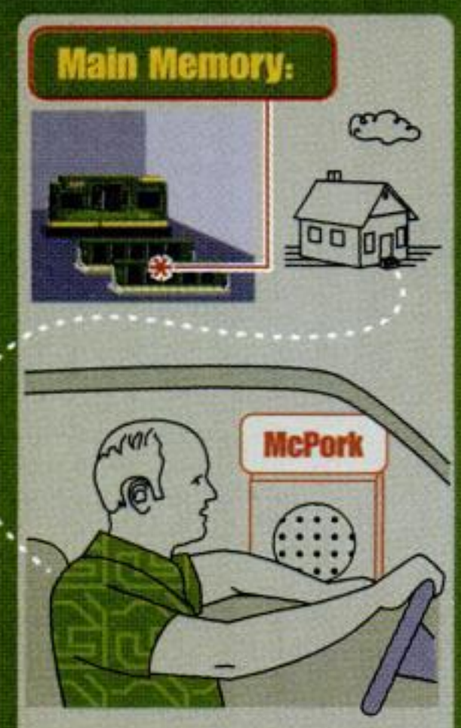
Food in your mouth
Since they're already onboard the CPU, the registers don't waste any time getting the processor the pork that it craves.



Food in your hand
Though not as immediate as the CPU's registers, L1 cache still manages to get the pork to the processor in as little as one tick of the clock.



Food on your plate
Whether it's onboard the CPU or closely coupled with it, L2 cache requires the processor to put out more effort to digest the pork.



Food from a drive-thru
Main memory stores much more pork than L1 or L2 cache can hold, but the CPU has to wait for the slower memory to serve it up.

Food from a supermarket
Virtual memory is only limited by the size of your hard drive, so it holds a lot of pork. It's also the slowest at feeding your CPU.

Copyrighted material

SDRAM is only slightly more costly than good PC100 memory, but remains 100 percent compatible with its slower brother. Be sure that any SDRAM you buy today is rated PC133. This gives you future upgrade options, not to mention extra headroom when overclocking.

Another thing to consider when picking your SDRAM is its CAS latency rating. The CAS latency will generally be either CL-2 or CL-3; the number indicates how many clock cycles the memory chip needs in order to prepare for another transaction. CL-2 chips have a slight performance edge, and are worth shopping around for.

Though 166MHz flavors of SDRAM are possible, the SDRAM architecture isn't capable of getting much faster without an overhaul. Tweaks such as ESDRAM, which permits faster burst speeds, might help extend the life of traditional SDRAM, but it's clear that something better is needed for the long term.

Rambus

Intel's chosen successor to SDRAM is Rambus DRAM, a.k.a. Direct RDRAM. RDRAM differs from SDRAM in that it uses a narrower data bus that's clocked much faster. Currently available RDRAM modules run with an awe-inspiring effective bus speed of 800MHz, over a relatively narrow 16-bit bus. Because this small bus takes much less space to route on a motherboard than a traditional 64-bit bus takes, systems can get even more bandwidth by running two, four, or even more channels in parallel. With all these advantages, it's clear why Intel officially blessed RDRAM as its next-gen memory of choice—despite the reluctance of the rest of the memory industry to jump on the bandwagon.

Despite Intel's endorsement, RDRAM is having a tough time living up to the hype. Compatibility and timing issues that delayed the rollout of RDRAM systems have been solved, and problems with heat are easy to work around (Rambus RIMMs are the first memory modules to require heatsinks). But the real killer to the RDRAM dream is cost. Because RDRAM uses such a different memory interface, memory manufacturers face a sizable retooling cost to gear up their test and assembly facilities.

DDR memory delivers double the data rate of SDR memory.

DDR SDRAM

Most memory manufacturers are supporting RDRAM, if only to make Intel happy. But, off the record, almost all would prefer to see DDR SDRAM (dubbed PC200 and PC266) become the next memory of choice. DDR memory is the natural evolution of existing SDRAM designs, and as such, can take advantage of the existing assembly and test infrastructure. Also, DDR is an open industry standard that all memory manufacturers can build without having to pay for licensed designs from Rambus Inc. This means lower costs. DDR memory should eventually cost only slightly more than regular SDRAM, but for the same price, you get twice the speed.

DDR stands for "double data rate." PC100 SDRAM and PC200 DDR memory both use the same 100MHz bus clock, but DDR SDRAM gets tricky by shuffling data over the bus on both the rising and falling edge of the clock pulse—effectively doubling the raw speed by moving two bits per pulse instead of one. AMD, VIA, ALI, and Micron have already announced plans to move toward DDR memory instead of RDRAM in their core-logic chipsets, and Micron has even demonstrated a prototype DDR motherboard that out-benchmarks the fastest single-channel RDRAM systems. Intel is the only holdout, though even Intel has recently shown some signs of backing away from RDRAM and endorsing DDR memory.

Both RDRAM and DDR SDRAM are designed with enough scalability to last at least a few years, but memory engineers are already hard at work on even more advanced technologies to keep up with the ever-more ravenous appetites of future CPUs.

The Future

Intel and the memory industry have recently reached a truce, so it looks like we might avoid a standards war when the next generation of memory hits in 2003. For the next generation of DRAM, Intel is working with Samsung, Micron, Hyundai, NEC, and Infineon to co-develop a standard. Though the designs are still in the back-of-a-napkin phase, it's also reasonable to expect small bits of SRAM to be integrated with ever-faster DDR or QDR (quad data rate) SDRAM, improving latency while simultaneously cranking clocks up to deliver more bandwidth. As for size? Well, a gigabyte of main memory is probably a lot closer than you can imagine.

RAM	Bus Width	Speed	Max Theoretical Bandwidth
PC100	64 bits	100MHz	800MB/s
PC133	64 bits	133MHz	1.1GB/s
RDRAM	16 bits	400MHz	x 2 1.6GB/s
PC200 DDR	64 bits	100MHz	x 2 1.6GB/s
PC266 DDR	64 bits	133MHz	x 2 2.1GB/s

Speed Strategies

If you're a memory designer itching to go faster, there are only a handful of ways to get there:

GO FASTER: The simplest way to crank up the speed of memory is to, well, just crank up the speed. Traditional SDRAM is being pushed up to 166MHz and beyond in some graphics applications.

GO WIDER: If you can't get the amount of data you want by speed alone, the next best thing is to widen the data bus and suck up twice as many bits at once. But you can only go so far. Pentium CPUs request 64 bits at a time, and some graphics controllers can handle as much as 128. But it becomes real tricky to wire up anything more complicated than this.

GO TWICE: It is electrically very difficult to handle a fast clock across a memory bus, but some engineers have figured out ways to keep the clock at a sane speed while moving data twice as fast. DDR allows memory chips to send data on both the rising and falling edge of a clock pulse, doubling the effective speed. A similar technique is used on the AGP bus to achieve 2x and 4x speeds.

GO THIN: Rambus has taken a unique approach in designing its RDRAM memory: Make the channel only 16-bits wide, but clock it really, really fast. RDRAM typically runs at 800MHz (actually 400MHz, double-clocked), and can provide even more potential bandwidth if several Rambus channels are run in parallel (as in Intel's high-end 840 server chipset).

GO PARALLEL: If you can manage the complexity and cost of two (or more) memory systems, nothing beats the raw speed of doing things in parallel on multiple memory buses. This is sometimes done to create fast interleaved main memory for high-end servers. In the graphics arena, 3dfx has proven to be a master of this game.

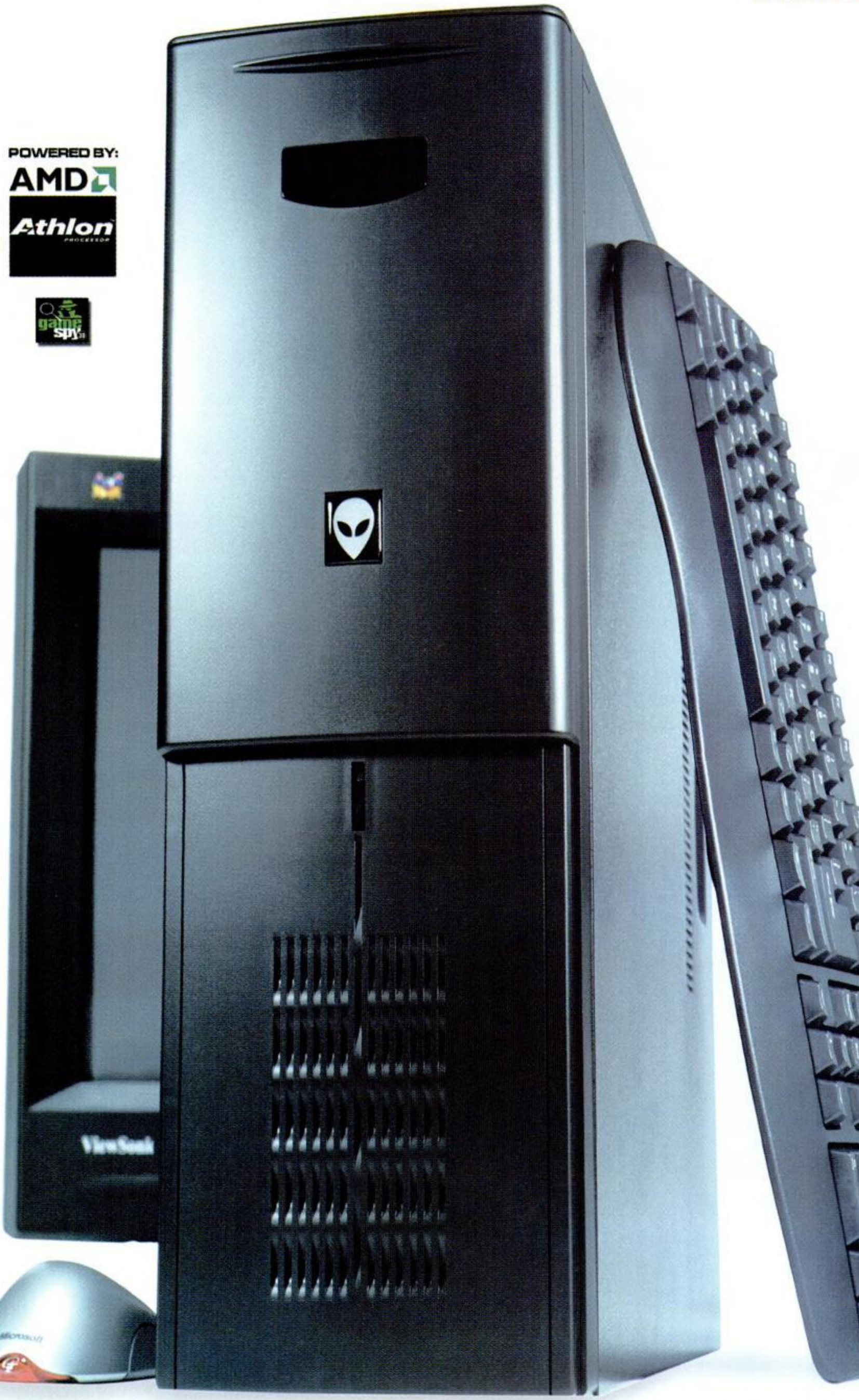
GO INSIDE: The absolute ultimate in speed is to follow the path pioneered by Neomagic: Merge DRAM with logic to create a system with all the necessary memory internal to the chip. Bringing the memory inside provides two potentially huge advantages: low cost and high speed. System cost can be reduced because there is no need for external memory buses or complicated layout. And speed can conceivably go through the roof, because internal memory architectures don't face some of the constraints of external memory. A 2048-bit interface to memory seems insane externally, but it's do-able when everything's inside. The downside is that adding even a few MB's of internal memory can vastly increase the size and cost of a chip. This technology is only just now starting to become practical.

Copyrighted material

"The fastest PC we've ever tested, bar none!"

- Maximum PC

POWERED BY:
AMD
Athlon PROCESSOR



ALSO AVAILABLE IN BEIGE

AWARD-WINNING SYSTEMS

Copyrighted material

Looks are nice but performance is everything.

Be a proud owner of an Alienware machine with it's legendary performance. You can rest assure that it will be backed up with 24/7 toll-free, onsite technical support. You can customize it online or have an experienced member of our staff guide you in customizing a machine for your specific needs. Alienware, the fastest system you'll ever use. Our slogan holds true; build it as if it were your own.

GREY

AMD Duron 700MHz Processor
High-Performance Heatsink/Cooling System
VIA KT133 Chipset Motherboard
Kingston 128MB SDRAM (PC-133)
Floppy Drive 1.44MB
15GB 7200RPM Hard Drive Ultra ATA100
Nvidia GeForce w/32MB DDR Video Card
SoundBlaster LIVE! 3D Sound Card
Cambridge FPS1000 Digital
Subwoofer/Speaker System
56X EIDE CD-ROM Player
Hydraulic ATX Mid-Tower Case w/300 Watt
104-Enhanced Keyboard PS/2
Microsoft Intellimouse PS/2
US Robotics V.90 56K Voice/Fax/Modem
Microsoft Windows Millennium OS
1-Year Toll-Free 24/7 Technical Support
with Aliencare On-Site Home Service
Personalized Technical Support Manual
Optimized & Configured for High-Performance
FREE FUNC Technical Surface Pad

$1,299.00
Financing as low as: $28.00mo./60mos.

HIVE-MIND

AMD Thunderbird 950MHz Processor
High-Performance Heatsink/Cooling System
VIA KT133 Chipset Motherboard
Kingston 128MB SDRAM (PC-133)
Floppy Drive 1.44MB
20GB 7200RPM Hard Drive Ultra ATA 100
Nvidia GeForce2 GTS 32MB DDR Video Card
SoundBlaster LIVE! 3D Sound Card
Altec Lansing ACS54 Gaming
5-Piece Subwoofer/Speaker System
Pioneer 16X/40X DVD Player
Hydraulic ATX Mid-Tower Case w/300 Watt
104-Enhanced Keyboard PS/2
Microsoft Intellimouse PS/2
US Robotics V.90 56K Voice/Fax/Modem
Microsoft Windows Millennium OS
1-Year Toll-Free 24/7 Technical Support
with Aliencare On-Site Home Service
Personalized Technical Support Manual
Optimized & Configured for High-Performance
FREE FUNC Technical Surface Pad

$2,299.00
Financing as low as: $53.00mo./60mos.

AREA51: AURORA

AMD Thunderbird 1000MHz Processor
High-Performance Heatsink/Cooling System
VIA KT133 Chipset Motherboard
Kingston 256MB SDRAM (PC-133)
Black Floppy Drive 1.44MB
40GB 7200RPM Hard Drive Ultra ATA100
Nvidia GeForce2 GTS 64MB DDR Video Card
SoundBlaster LIVE! 3D Sound Card
Klipsch 4.1 ProMedia v.2-400 THX
400-Watt Subwoofer/Speaker System
Pioneer 16X/40X DVD Player
HP 9300i CDR-W 10x/4x/32x CD Writer
Hydraulic Black ATX Mid-Tower Case w/300 Watt
Black 107-Enhanced Keyboard PS/2
Microsoft Intellimouse Explorer
US Robotics V.90 56K Voice/Fax/Modem
Microsoft Windows Millennium OS
1-Year Toll-Free 24/7 Technical Support
with Aliencare On-Site Home Service
Personalized Technical Support Manual
Optimized & Configured for High-Performance
FREE FUNC Technical Surface Pad

$3,299.00
Financing as low as: $77.00mo./60mos.

MONITORS

17" Viewsonic G773 .26dp	*$295.00*
17" Viewsonic Q95 .23dp	*$335.00*
17" Viewsonic E790B .26dp	*$395.00*
21" Viewsonic P810 .26dp	*$825.00*

TOLL FREE: 800-494-3382
www.alienware.com

ALIENWARE

ALIENWARE.COM

Copyrighted material

The Straight Talk People℠

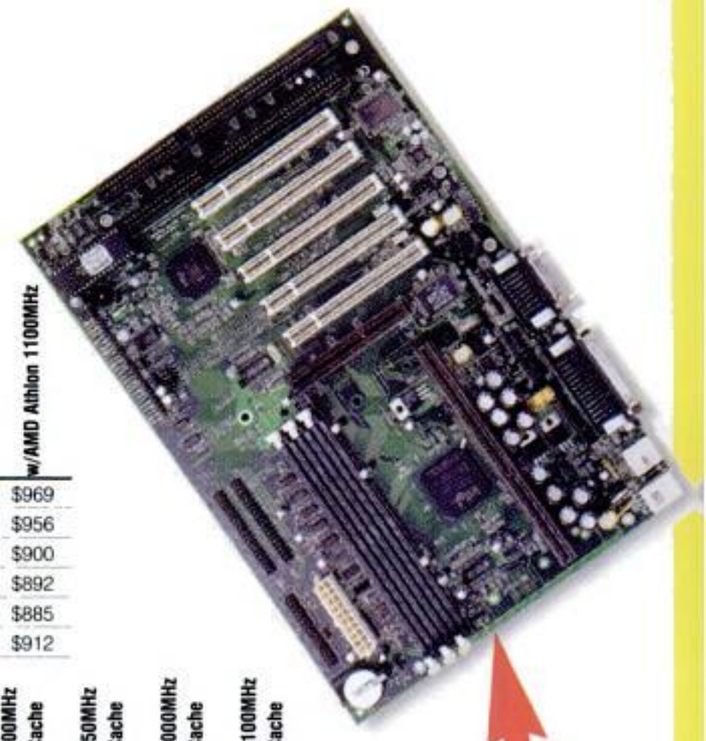
SINCE 1991

ABERDEEN

MOTHERBOARD GEEK HEAVEN!

Super7™

	Part Number	Chip Set	L2 Cache (KB)	Maximum Memory (MB)	168-pin DIMM Sockets	72-pin SIMM Sockets	Flash BIOS	Integrated Audio	Integrated Controller	PCI Slots	ISA Slots	AGP Slot	Format	Manufacturer's Warranty	Motherboard Only	w/AMD-K6®-2/500	w/AMD-K6-2/550	w/Intel® Pentium® MMX™ 233MHz
EPoX EP-MVP3C2	*MB5406*	VIA Apollo MVP3	512	384	3		Award		UltraDMA/66	4	2	1	Baby AT	2 Yrs.	$85	$144	$170	$145
EPoX EP-MVP3G5	*MB5405*	VIA Apollo MVP3	2048	384	3		Award		UltraDMA/66	5	2	1	ATX	2 Yrs.	$110	$169	$195	$170
FIC VA-503+	*MB5211*	VIA Apollo MVP3	1024	512	2	4	Award			3	3	1	Baby AT	1 Yr.	$76	$135	$161	$136
Pine VA7-AV	*MB5300*	VIA Apollo MVP4	512	768	3		Award	AC-97	UltraDMA/66	5	2		ATX	3 Yrs.	$93	$152	$178	$153
Shuttle HOT-591P	*MB5611*	VIA Apollo MVP3	512	256	2	2	Award			3	3	1	Baby AT	1 Yr.	$80	$139	$165	$140
Tyan S1590S Trinity 100AT	*MB5006*	VIA Apollo MVP3	1024	384	3	2	Award			4	4	1	Mini AT	3 Yrs.	$99	$158	$184	$159



Slot A

	Part Number	Chip Set	Maximum Memory (MB)	168-pin DIMM Sockets	Flash BIOS	Bus Frequency	Integrated Controller	PCI Slots	ISA Slots	AGP Slot	Format	Manufacturer's Warranty	Motherboard Only	w/AMD Athlon™ 750MHz	w/AMD Athlon 800MHz	w/AMD Athlon 850MHz	w/AMD Athlon 900MHz	w/AMD Athlon 950MHz	w/AMD Athlon 1000MHz	w/AMD Athlon 1100MHz
ABIT KA7-100	*MB7502*	VIA Apollo KX133	2048	4	Award	200/133	UltraDMA/100	6	1	1	ATX	1 Yr.	$189	$384	$409	$474	$514	$614	$759	$969
Asus K7V	*MB7703*	VIA Apollo KX133	1536	3	Award	200/133	UltraDMA/66	5		1	ATX	1 Yr.	$176	$371	$396	$461	$501	$601	$746	$956
EPoX EP-7KXA	*MB7850*	VIA Apollo KX133	768	3	Award	200/133	UltraDMA/66	5	1	1	ATX	2 Yrs.	$120	$315	$340	$405	$445	$545	$690	$900
FIC SD11	*MB7401*	AMD-751 / VIA 686A	768	3	Award	100	UltraDMA/66	5	1	1	ATX	1 Yr.	$112	$307	$332	$397	$437	$537	$682	$892
Shuttle AI61	*MB7901*	AMD-750	768	3	Award	100	UltraDMA/66	5		1	MicroATX	1 Yr.	$105	$300	$325	$390	$430	$530	$675	$885
Tyan S2380 Trinity K7	*MB7000*	VIA Apollo KX133	768	3	Award	200/133	UltraDMA/66	6	1	1	ATX	3 Yrs.	$132	$327	$352	$417	$457	$557	$702	$912

Socket A

	Part Number	Chip Set	Maximum Memory (MB)	168-pin DIMM Sockets	Flash BIOS	Bus Frequency	Integrated Controller	PCI Slots	ISA Slots	AGP Slot	Format	Manufacturer's Warranty	Motherboard Only	w/AMD Duron™ 600MHz	w/AMD Duron 650MHz	w/AMD Duron 700MHz	w/AMD Duron 750MHz	w/AMD Athlon™ 750MHz with Enhanced Cache	w/AMD Athlon 800MHz with Enhanced Cache	w/AMD Athlon 850MHz with Enhanced Cache	w/AMD Athlon 900MHz with Enhanced Cache	w/AMD Athlon 950MHz with Enhanced Cache	w/AMD Athlon 1000MHz with Enhanced Cache	w/AMD Athlon 1100MHz with Enhanced Cache
ABIT KTV	*MB7503*	VIA Apollo KT133	1536	3	Award	200/133	UltraDMA/66	6	1	1	ATX	1 Yr.	$169	$252	$269	$299	$344	$364	$389	$454	$494	$594	$739	$949
ABIT KTV-RAID	*MB7504*	VIA Apollo KT133	1536	3	Award	200/133	DMA/100 RAID	6	1	1	ATX	1 Yr.	$199	$282	$299	$329	$374	$394	$419	$484	$524	$624	$769	$979
ASUS A7V	*MB7704*	VIA Apollo KT133	1536	3	Award	200/133	UltraDMA/100	5		1	ATX	1 Yr.	$173	$256	$273	$303	$348	$368	$393	$458	$498	$598	$743	$953
EPoX EP-8KTA	*MB7851*	VIA Apollo KT133	768	3	Award	200/133	UltraDMA/66	6	1	1	ATX	2 Yr.	$157	$240	$257	$287	$332	$352	$377	$442	$482	$582	$727	$937
FIC AZ11	*MB7402*	VIA Apollo KT133	1536	3	Award	200/133	UltraDMA/66	5		1	ATX	1 Yr.	$144	$227	$244	$274	$319	$339	$364	$429	$469	$569	$714	$924
Microstar K7T Pro	*MB7203*	VIA Apollo KT133	1536	3	Award	200/133	UltraDMA/66	5		1	ATX	1 Yr.	$159	$242	$259	$289	$334	$354	$379	$444	$484	$584	$729	$939

Slot 1

	Part Number	Chip Set	Maximum Memory (MB)	168-pin DIMM Sockets	168-pin RIMM Sockets	Flash BIOS	Integrawed Audio	Integrawed Controller	PCI Slots	ISA Slots	AGP Slot	Formaw	Manufacturer's Warranty	Motherboard Only	w/Intel® Pentium III® 600/B 512K 100/133MHz FSB	w/Intel Pentium III 700 256K OD 100MHz FSB	w/Intel Pentium III 733 256K OD 133MHz FSB	w/Intel Pentium III 750 256K OD 100MHz FSB	w/Intel Pentium III 800/EB 256K OD 100/133MHz FSB	w/Intel Pentium III 850 256K OD 100MHz FSB	w/Intel Pentium III 933 256K OD 133MHz FSB	w/Intel Pentium III 1000 256K OD 133MHz FSB	w/Dual Intel Pentium III 600 512K 100MHz FSB	w/Dual Intel Pentium III 850 256K OD 100MHz FSB
ABIT BE6-II	*MB6508*	Intel 440BX	768	3		Award		UltraDMA/66	5	1	1	ATX	1 Yr.	$141	$341	$376	N/A	$431	$446	N/A	N/A	N/A	N/A	N/A
ABIT BX133-RAID	*MB6513*	Intel 440BX	768	3		Award		DMA/100 RAID	5	1	1	ATX	1 Yr.	$199	$399	$434	N/A	$489	$504	N/A	N/A	N/A	N/A	N/A
ABIT VT6X4	*MB6510*	VIA Apollo Pro 133A	768	3		Award	AC-97	UltraDMA/66	5	2	1	ATX	1 Yr.	$105	$305	$340	$340	$395	$410	$525	$715	$925	N/A	N/A
ASUS P2B-DS (Dual)	*MB6707*	Intel 440BX	1024	4		Award			4	2	1	ATX	1 Yr.	$512	$712	$747	N/A	$802	$817	N/A	N/A	N/A	$912	$1352
ASUS P3B-F	*MB6720*	Intel 440BX	1024	4		Award			6	1	1	ATX	1 Yr.	$141	$341	$376	N/A	$431	$446	N/A	N/A	N/A	N/A	N/A
ASUS P3V4X	*MB6723*	VIA Apollo Pro 133A	1024	4		Award		UltraDMA/66	6	1	1	ATX	1 Yr.	$130	$330	$365	$365	$420	$435	$550	$740	$950	N/A	N/A
EPoX EP-6VBA2	*MB6855*	VIA Apollo Pro 133A	768	3		Award	AC-97	UltraDMA/66	4	2	1	ATX	2 Yrs.	$105	$305	$340	$340	$395	$410	$525	$715	$925	N/A	N/A
Intel L440GX+ (Dual)	*MB6917*	Intel 440GX	2048	4		Intel/Phoenix		Adaptec 2-Ch U2W	6	1		ATX	3 Yrs.	$561	$761	$796	N/A	$851	$866	N/A	N/A	N/A	$961	$1401
Intel SE440BX-2 "Seattle"	*MB6921*	Intel 440BX	768	3		Intel/Phoenix			4	2	1	ATX	3 Yrs.	$120	$320	$355	N/A	$410	$425	N/A	N/A	N/A	N/A	N/A
Shuttle AV64	*MB6309*	VIA Apollo Pro 133A	768	3		Award		UltraDMA/66	5	2	1	ATX	1 Yr.	$96	$296	$331	$331	$386	$401	$516	$706	$916	N/A	N/A
SuperMicro P6DGU (Dual)	*MB6122*	Intel 440GX	2048	4		AMI		Adaptec U2W	5	2	1	ATX	1 Yr.	$485	$685	$720	N/A	$775	$790	N/A	N/A	N/A	$885	$1325
SuperMicro P6SBA	*MB6120*	Intel 440BX	768	3		AMI			4	3	1	ATX	1 Yr.	$103	$303	$338	N/A	$393	$408	N/A	N/A	N/A	N/A	N/A
SuperMicro P6SBU	*MB6128*	Intel 440BX	1024	4		AMI		Adaptec U2W	4	3	1	ATX	1 Yr.	$343	$543	$578	N/A	$633	$648	N/A	N/A	N/A	N/A	N/A
Tyan S1834 Tiger 133 (Dual)	*MB6020*	VIA Apollo Pro 133A	2048	4		Award		UltraDMA/66	6	1	1	ATX	3 Yrs.	$162	$362	$397	$397	$452	$467	$582	$772	$982	$562	$1002

Socket 370

	Part Number	Chip Set	Maximum Memory (MB)	168-pin DIMM Sockets	Flash BIOS	Integrated Audio	Integrated Video	Integrated Controller	PCI Slots	ISA Slots	AGP Slot	AMR or CNR Slot	Format	Manufacturer's Warranty	Motherboard Only	w/Intel® Celeron™ processor 566 MHz 128K OD 66MHz FSB	w/Intel Celeron 633 128K OD 66MHz FSB	w/Intel Celeron 667 128K OD 66MHz FSB	w/Intel Celeron 700 128K OD 66MHz FSB	w/Intel Celeron 733 128K OD 66MHz FSB	w/Intel Pentium III 733 256K OD 133MHz FSB	w/Intel Pentium III 800/EB 256K OD 100/133MHz FSB	w/Intel Pentium III 850 256K OD 100MHz FSB	w/Intel Pentium III 866 256K OD 133MHz FSB	w/Intel Pentium III 933 256K OD 133MHz FSB	w/Intel Pentium III 1000 256K OD 133MHz FSB
ABIT SE6	*MB6512*	Intel 815E	768	3	Award	Intel 815E	Intel 815E		6		1	1	ATX	1 Yr.	$172	$259	$287	$310	$341	$379	$407	$477	$592	$607	$782	$992
ABIT VH6	*MB6511*	VIA Apollo Pro 133A	768	3	Award	AC-97			5	1	1	1	ATX	1 Yr.	$113	$200	$228	$251	$282	$320	$348	$418	$533	$548	$723	$933
ASUS CUBX	*MB6726*	Intel 440BX	1024	4	Award	AC-97			6	1	1		ATX	1 Yr.	$149	$236	$264	$287	$318	$356	N/A	$454	$569	N/A	N/A	N/A
ASUS CUSL2	*MB6727*	Intel 815E	1536	3	Award	Intel 815E	Intel 815E		5	1	1	1	ATX	1 Yr.	$179	$266	$294	$317	$348	$386	$414	$484	$599	$614	$789	$999
ASUS CUV4X	*MB6725*	VIA Apollo Pro 133A	1536	3	Award	AC-97			5	1	1	1	ATX	1 Yr.	$130	$217	$245	$268	$299	$337	$365	$435	$550	$565	$740	$950
EPoX EP-3VCA	*MB6854*	VIA Apollo Pro 133A	768	3	Award	AC-97			4	1	1	1	ATX	2 Yrs.	$105	$192	$220	$243	$274	$312	$340	$410	$525	$540	$715	$925
FIC FA11	*MB6412*	VIA Apollo Pro 133A	1024	4	Award				5	2	1		ATX	1 Yr.	$105	$192	$220	$243	$274	$312	$340	$410	$525	$540	$715	$925
Intel D815EEA "Easton"	*MB6922*	Intel 815E	512	3	Award	Intel 815E	Intel 815E		5		1	1	ATX	3 Yrs.	$175	$262	$290	$313	$344	$382	$410	$480	$595	$610	$785	$995
Shuttle AV14	*MB6311*	VIA Apollo Pro 133A	768	3	Award				5	2	1		ATX	1 Yr.	$96	$183	$211	$234	$265	$303	$331	$401	$516	$531	$706	$916
Shuttle ME64	*MB6310*	Intel 810E	512	2	Award	Intel 810E	Intel 810E		3			1	Micro ATX	1 Yr.	$114	$201	$229	$252	$283	$321	$349	$419	$534	$549	$724	$934
SuperMicro 370SEA	*MB6140*	Intel 810E	512	2	AMI	Intel 810E	Intel 810E		6	1		1	ATX	1 Yr.	$142	$229	$257	$280	$311	$349	$377	$447	$562	$577	$752	$962
SuperMicro 370DLE (Dual)	*MB6154*	ServerWorks LE	2048	2	AMI				6	1			ATX	1 Yr.	$342	$429	$457	$480	$511	$549	$577	$647	$762	$777	$952	$1162
SuperMicro 370DL3 (Dual)	*MB6155*	ServerWorks LE	2048	2	AMI				6	1			ATX	1 Yr.	$545	$632	$660	$683	$714	$752	$780	$850	$965	$980	$1155	$1365
Tyan S1854 Trinity 400	*MB6018*	VIA Apollo Pro 133A	768	3	Award				6	1	1		ATX	3 Yrs.	$109	$196	$224	$247	$278	$316	$344	$414	$529	$544	$719	$929

Slot 2

	Part Number	Chip Set	Maximum Memory (MB)	168-pin DIMM Sockets	Flash BIOS	Integrated Audio	Integrated Video	Integrated Controller	Integrated Networking	PCI Slots	ISA Slots	AGP Slot	Format	Manufacturer's Warranty	Motherboard Only	w/Intel® Pentium III® Xeon™ 550MHz 512K 100MHz FSB	w/Intel Xeon 550MHz 1M 100MHz FSB	w/Intel Xeon 550MHz 2M 100MHz FSB	w/Dual Intel Xeon 550MHz 512K 100MHz	w/Quad Intel Xeon 550MHz 512K 100MHz	w/Intel Xeon 700MHz 1M 100MHz FSB	w/Intel Xeon 700MHz 2M 100MHz FSB	w/Dual Intel Xeon 700MHz 1M 100MHz	w/Quad Intel Xeon 700MHz 1M 100MHz
SuperMicro S2DL3	*MB6156*	ServerWorks LE	4096	4	AMI			Adaptec Ultra160	Intel 82552	6	1		ATX	1 Yr.	$676	$1776	$3006	$5016	$2876	N/A	$2076	$3026	$3476	N/A
SuperMicro S2QR6	*MB6190*	ServerWorks HE	16384	16	AMI			Adaptec 2-Ch Ultra160	Intel 82559	8			SWTX	1 Yr.	$2732	$3832	$5062	$7072	$4932	$7132	$4132	$5082	$5532	$8332

You may get a "steal" on a motherboard like this for only $1 at www.aberbid.com

800-501-9464

www.aberdeeninc.com/max

Technology Solutions for Tomorrow!

PC Mall

The Best Deals Delivered Tomorrow!

500MHz
Intel® Celeron™ processor
64MB RAM, 10.2GB Hard Drive
40X CD-ROM
$449
Pavilion 6630
#951916
Manufacturer reconditioned. Monitor and speakers sold separately.

Blowout Systems!

650MHz
Intel® Pentium® III processor
128MB RAM, 40GB Hard Drive
DVD, CD-RW
$999
HP Pavilion 9680c
#54891
Manufacturer reconditioned. Monitor and speakers sold separately.

500MHz
Intel® Pentium® III processor
64MB RAM, 13GB Hard Drive
Includes DVD!
$499
Tower 500A
#950995
Manufacturer reconditioned. Monitor and speakers sold separately.

Cameras

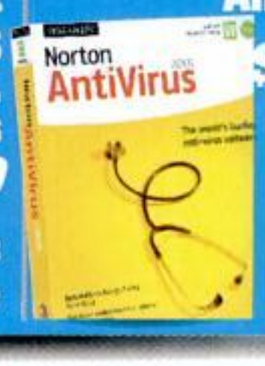
DCR-TRV20 Camcorder
Call for best price.
#80282
PC Mall is an authorized camcorder dealer for Sony, Canon, Panasonic and JVC

D-360L Digital Camera
$299.99
#57140
While supplies last!

New Software! Upgrade Today!

NEW! Microsoft Windows Millennium Ed. as low as
$49.99
#85088
Upgrade from Windows 98

NEW! Norton AntiVirus 2001
$28.99
#850103
Price reflects $10 mfr. mail-in upgrade rebate from Norton AntiVirus 2000.



NEW!
Small and Light!
Palm m100 Organizer
$149.99
#951523

NEW!
HP 9340i 10x4x32 Int. EIDE CD-RW Drive
$229.99
#951840

Best Seller!
HP DeskJet 932C Color Printer
$199.99
#57053

Call for best prices!

Notebooks starting at $869!

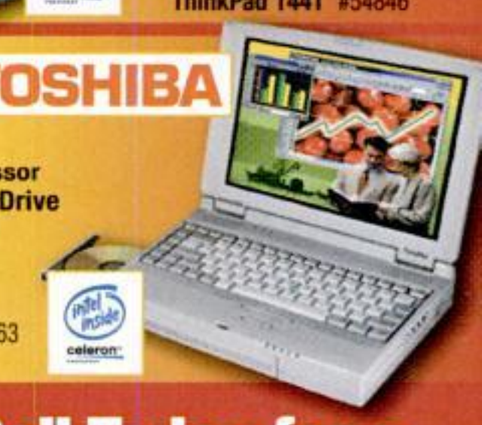
566MHz
Intel® Celeron™ processor
64MB RAM, 6GB Hard Drive,
24X CD-ROM, 13" HPA display
$1,499
Presario 14XL244 #848674

500MHz
Intel® Celeron™ processor
32MB RAM, 6GB Hard Drive
12.1" High-Performance Addressing display
$1,149
ThinkPad 1210 #950143

650MHz
Intel® Pentium® III processor
64MB RAM, 12GB Hard Drive,
DVD, 56K Modem,
14.1" TFT display
$2,199
Satellite 2775XDVD #951484

466MHz
Intel® Celeron™ processor
64MB RAM, 6GB Hard Drive,
24X CD-ROM, 56K Modem,
12.1" Active Matrix display
Includes DVD!
$1,199
ThinkPad 1441 #54846

600MHz
Intel® Celeron™ processor
64MB RAM, 6GB Hard Drive
13" Dual Scan display
$1,199
Satellite 2250XCDS #842663



Call Today for a FREE PC Mall Catalog!

Prices and specifications subject to change without notice. We do our best to be accurate but occasionally mistakes occur. We are not responsible for any typographical, photographic or technical errors. NOTE: Products and packaging depicted may differ from stock available at time of shipment; we reserve the right to substitute equivalent items. While supplies last.

Use Priority Code #ZPMP090

1-800-315-0026 pcmall.com

Fastest Overnight Delivery! Place your order as late as 10:00 p.m. EST and get it by 10:30 a.m. the next morning! FedEx

Motherboards

Slot 1 Motherboards
Asus P3-B-F, 440 BX chipset, ATX, $135
Asus P3CD, Dual, 820, Rimm, ATX $ 419
Asus P3V-133, VIA, ATX, $ 98
Asus P3V4X, VIA, ATX $119
Abit BE6-II, 440 BX chipset, ATX $139
Abit WX6 Intel 810 chipset, ATX $129
DFI PA61 VIA chipset, 133 bus, U66 $93
Tyan S1854, VIA 133, U66, $106

Slot A Motherboards (Athlon)
Asus K7M, U66, ATX, $149
Asus K7V, VIA 133, ATX U66 $ 171
FIC SD11, U66, ATX, $119
Gigabyte 7IX, U66, ATX $139
Abit KT7, VIA 133, U100, AGP4x $171
Tyan S2380, U66, VIA 133, AGP4x $132
Microstar MS-6195, U66, ATX, $134

Super Socket 7 Motherboards
Asus P5-AB, AT, 512k cache $95
Asus P5-A, ATX, 512k cache $97
DFI K6-BV3+, AT, 2 meg cache $94
Tyan S1590, AT, 1meg cache $99
Tyan S1598c2, ATX, 2 meg cache $128

Socket 370 Motherboards
Asus ME99, SIS620, ATX $88
Asus CUV4X, VIA, U66, AGP4x $133
Asus CUBX, IntelBX, ATX, U66 $146
Asus CUSL2, i815 AGP4x,ATX, $169
Tyan S1854, 370 & slot 1, ATX $106
Abit ZM6, 440ZX, ATX $94

Socket A Motherboards (Thunderbird/Duron)
FIC AZ11, ATX, VIA, U66, AGP4x $146
Asus A7V, ATX, VIA U100 AGP4x $169
DFI AK74, ATX, U66, AGP4x $118
Gigabyte 7ZX-1, U66, AGP4x $138

Hard Drives

Western Digital 15 gig $94 U-66 5400
Western Digital 20 gig $136 U-66 7200
Western Digital 30 gig $133 U-66 5400
Western Digital 45 gig $180 U-66 5400
Maxtor 15 gig $94 U-66 5400 rpm
Maxtor 20 gig $129 U-66 7200 rpm
Maxtor 30 gig $166 U-66 7200 rpm
Maxtor 40 gig $228 U-100 7200 rpm
Maxtor 61 gig $265 U-66 5400 rpm
IBM 15 gig $122 U-100 7200 rpm
IBM 20 gig $159 U-100 7200 rpm
IBM 30 gig $169 U-100 7200 rpm
IBM 45 gig $238 U100 7200 rpm
IBM 60 gig $464 U100 7200 rpm
IBM 75 gig $599 U100 7200 rpm
Seagate 20 gig $132 2meg U-66 7200 rpm
Seagate 30 gig $182 2meg U-66 7200 rpm
Samsung 10 gig $ 85 U66 5400 rpm
Promise Ultra 66 Controller Card, PCI $35
Promise Ultra 100 Controller Card PCI $47
Promise Fast Trak 100 raid/mirror card $114
Tekram SCSI card 50 pin $29, Ultra 2 $148
Adaptec 2940 U-2-W SCSI Controller $219
Go to our website for more hard drives

Memory

SDram 168 pin dimms

	PC-133	PC-100	PC-66
32 megs		$43	$39
64 megs	$80	$76	$75
128 megs	$156	$164	$146
256 megs	$319	$316	

RamBus Dram
184 pin 800 MHz. 128 meg $ 342
184 pin 800 MHz. 256 meg $ See Web

Check website for current pricing

Cases

Model 6306 ATX Mid Tower 250 watt $79
Model 6306 ATX Mid Tower 300 watt $99
Model 9106 ATX Full Tower 300 watt $125
Enlight Mid Tower ATX 250 watt $79
848C AT Mid Tower 250 watt $33
Cooler Master ATC 200 Mid Tower ATX $295
Goto our website to see pictures of all cases
More cases on our Website

Video Cards

Asus V-6800 GeForce 256 DDR, 32 meg $299
Asus V7700 GeForce-2 64 meg DDR $see web
Creat. Labs Geforce 2, Annihilator2, 32mg 328
Creat. Labs NVidia TnT-2 32 meg $95
Elsa Erazor 3 NVidia TnT-2 32mg $81
Elsa Erazor Geforce 32 megDDR $269
Elsa Gladiac Geforce 2,32mg $366, 64mg $449
Guillemt Geforce 2 GTS , 32mg/64mg $see web
ATI Rage Fury MAX 64 meg $142
ATI Radeon 32meg, DDR $ 275, 64 meg $see web
Jaton NVidia TnT-2 32 meg $77
Daytona Geforce-2 32meg $128
Daytona TnT-2 Pro 32 meg $91
Matrox G400 MAX 360 RamDac, 32 mg $see web
Matrox G400 300 RamDac, 32 meg $122
Trident 9880 8 meg AGP $42, PCI $40
STB VooDoo5 5500 64 mg DualChip SLI $303
LeadTech Geforce 2 GTS 64mg $418
Check Website for more Video Cards

Sound Cards

Sound Blaster Live Plantinum $182
Sound Blaster Live X-Gamer $95
Sound Blaster Live MP3+ $94
Sound Blaster Live Value $59
Diamond Monster MX300 $54
Diamond Monster MX 400 $58
Sound Blaster 16 PnP $25

Processors

Intel Pentium III Processors
Flip Chip FC-PGA, 256k cache
700 $207 733 $209 750 $257
800 $269 850 $385 866 $392
933 $557

Slot 1 Processors
700-256k $219 733-256k $212
750-256k $263 800-256k $285
850-256k $394 933-256k $569

AMD Processors
Socket 7 Processors
K-6-2 450 MHz. $62 K-6-2 500 MHz. $78
K-6-2 550 MHz. $114

Athlon K7 Slot A Processors
700 $164 750 $173 800 $157
900 $307 950 $409 1 GHz $514

Thunderbird Socket A Processors
700 $164 800 $209 850 $269
900 $309 950 $409 1 GHz. $529

Cooler Master P-3 Heatsink & Cooling Fan $22
Cooler Master Heatsink/Fan,Socket 7/A/370 $12
Cooler Master AMD K7 Heatsink & Fan $18 Dual fan $28

*****product prices change daily, please see our website**

Your Hardware Component Source

Now in ATX Style

AMD Bare Bones Systems

AMD K6 Bare Bones Systems

Specifications:
DFI-K6-XV3+ Motherboard w/ 2 megs of cache
Mid Tower ATX Case w/ 250 watt power supply
AMD Processor of your choice
System is assembled and burned in for 48 hours
****Now includes a heatsink/cooling fan unit****

AMD K-6-2 450 MHz. $225
AMD K-6-2 500 MHz. $235
AMD K-6-2 550 MHz. $265

AMD K7 Bare Bones Systems

AMD K7 Thunderbird Bare Bones Systems

Specifications:
FIC AZ11 Motherboard, Socket A
Mid Tower ATX Case w/ 300 watt power supply
AMD Processor of your choice
Heatsink and Cooling Fan
System is assembled and burned in for 48 hours

AMD K-7 700 MHz. $398
AMD K-7 800 MHz. $466
AMD K-7 900 MHz. $549
AMD K-7 1 GHz. $869

Custom Build your own Bare Bones System on our website!

Our Website is completely safe for online orders. We use SSL Encryption from Verisign

VeriSign™ VeriSign Secure Site BBB Member BBB Online

Computer Services Group
Ordering Made Simple

1. **Goto www.csg2000.com**
2. **Get Real time pricing & Spec's**
3. **Use our secure server 24-7 and place your order**

product prices change daily, please see our website

We also ship to PO Boxes and Military addresses

Our Address for shipping/mailing: 1927 Harbor Blvd. #395, Costa Mesa, CA 92627, Telephone # 800-798-1880, Fax # 949-646-7029
30 day return period for refunds from purchase date, after 30 days only warranty exchange, no returns on software. All returns require an RMA # please email or g to our website to get an RMA #, shipping is non refundable, complete return policy can be found on our website.

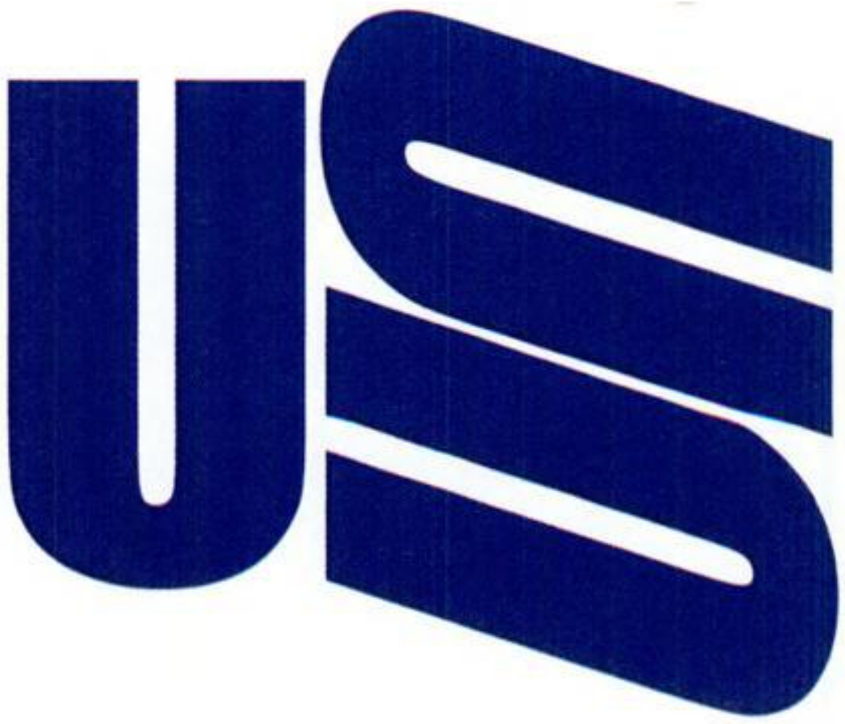
Copyrighted material

Q: If you were the latest video card, the fastest hard drive, the coolest digital camera, or that hot new motherboard,

WHERE WOULD YOU BE?

www.upgradesource.com

Performance Computer Hardware



Video Cards
Processors
Digital Cameras
Hard Drives
Motherboards
Scanners
Printers
Monitors
Speakers
& More!

Upgrade Source
(800) 961-5889

The High-Performance Store
www.upgradesource.com

Copyrighted material

We're committed to serving you...

To provide the best customer service possible, we have listed details of how to reach us below.

SUBSCRIPTION INQUIRIES

If you have a change of address, invoice or renewal questions, or haven't received Maximum PC by the first day of the issue month, please contact us:

WRITE: Maximum PC
Customer Service
150 North Hill Drive
Brisbane, CA 94005
CALL: 800.274.3421
E-MAIL: custserv@maximumpc.com

When writing us, please include your mailing label showing your address. Please allow at least six weeks notice for any change in subscription record.

BACK ISSUES AND CDs

The price per copy for back issues within the U.S. is $8.99 including postage. For foreign orders, send $12.00 in U.S. funds, which includes airmail delivery.

To order just the Maximum CD within the U.S., send us $7.95 which includes postage. For foreign orders, send $10.00 which includes airmail delivery.

All orders must be prepaid and sent to the following address:

MAXIMUM PC
Customer Service
150 North Hill Drive
Brisbane, CA 94005

CREDIT CARD ORDERS:
CALL: 800.274.3421, M-F, 5 a.m.-8 p.m. PST;
Sat/Sun, 6 a.m.-3:30 p.m. PST
E-MAIL: subscribe@maximumpc.com
(type "Maximum PC" in the subject line)

RENTING SUBSCRIBER NAMES

Maximum PC occasionally rents our subscriber list to other companies that we think offer products of interest to our readers. If you would like your name removed from this list, please let us know.

TECHNICAL SUPPORT FOR THE MAXIMUM CD

We are committed to bringing you the best possible disc every month. In the disc pages, we provide the phone numbers of the companies whose demos are featured on the Maximum CD!
Please call these companies to assist you with technical support.
ONLINE SUPPORT: http://support.imagine-inc.com/

TO REPLACE A DAMAGED DISC

WRITE: Maximum PC
Attn: Disc Replacement
150 North Hill Drive
Brisbane, CA 94005
CALL: 800.274.3421, M-F, 9 a.m. - 5 p.m. PST;
Sat/Sun, 6 a.m.-3:30 p.m. PST
E-MAIL: custserv@maximumpc.com
(type "Maximum PC" in the subject line)

GIFT SUBSCRIPTIONS

To order a gift subscription of Maximum PC for a fellow PC lover, call 800.706.9500.

For more information on PowerUser advertisers' products and services, please contact the companies below:

COMPANY	URL/PHONE NUMBERS	PAGE(S)
3dfx Interactive	www.3dfx.com	28
Aberdeen	www.aberdeeninc.com/max	92
Adaptec	www.adaptec.com	78
Alienware	www.alienware.com	90-91
Advanced Micro Devices	www.amd.com	25
American Power Conversion	www.apcc.com	38
ATI Technologies	www.atitech.ca	41
Boston Acoustics	www.bostonacoustics.com	52
Compaq Computer Corporation, Inc	www.compaq.com	C2-1
Computer Services Group	www.csg2000.com	94
Creative Labs	www.creative.com	20, 36
Crucial Technology	www.crucial.com	2
Dell Computer Corporation	www.dell.com	C5-C8
Deneba Software	www.deneba.com	59
Kensington	www.trackballs.kensington.com	55
Microsoft	www.microsoft.com/	7, 30, 13
nVidia	www.nvidia.com	16
PC Mall	www.pcmall.com	93
PC Power & Cooling	www.pcpowercooling.com	22
Plextor	www.plextor.com	44
Samsung Electronics America, Inc.	www.samsung.com	74
Sony	www.sony.com/di	4-5
TDK	www.tdk.com	8-9
Upgrade Source Inc.	upgradesource.com	95
Turtle Beach Systems	www.voyetra.com	68
Winbook	www.winbook.com	62

MAXIMUM PC (ISSN 1522-4279) is published monthly by Imagine Media Inc., 150 North Hill Drive, Suite 40, Brisbane, CA 94005, USA. Periodical class postage paid in Brisbane, CA, and at additional mailing offices. Newsstand distribution is handled by Curtis Circulation Company. Basic subscription rates: one year (12 issues) US: $20; Canada: $34; Foreign: $44. Basic subscription rates "Deluxe" version (w/CD): one year (12 issues/12 CD-ROMs) US: $30; Canada: $44; Foreign $54. US funds only. Canadian price includes postage and GST (GST#R128220688).

Outside the U.S. and Canada, price is $53.95, U.S. prepaid funds only. For customer service, write Maximum PC, P.O. Box 51479, Boulder, CO 80328-1479; Maximum PC, 150 North Hill Drive, Brisbane, CA 94005. Imagine Media also publishes PC Gamer, Next Generation, MacAddict, PC Accelerator, PlayStation Magazine, and Business 2.0. Entire contents copyright 1999, Imagine Media Inc. All rights reserved. Reproduction in whole or in part is prohibited. Imagine Media Inc. is not affiliated with the companies or products covered in Maximum PC.

PRODUCED AND PRINTED IN THE UNITED STATES OF AMERICA.

Copyrighted material

for newer technology, you'd need government clearance.

Dell's latest and greatest technology can be yours with or without the background check.

So you forgot to return a few library books and couldn't get into the FBI Academy. Well, here at Dell™, we don't discriminate. All of our customers are afforded the latest and greatest technology. Like the New Inspiron™ 4000, the ultimate balance of uncompromising performance and mobility. And, of course, we have all of the latest in printers, scanners, and software. So call on us to help build your perfect system or choose from one of these great systems below. Even easier than getting a library card.

NEW—Dell™ Inspiron™ 4000 Notebook

DELL™ NOTEBOOKS:

DELL™ INSPIRON™ 3800

Design and Affordability

- Intel® Celeron™ Processor at 600MHz
- 12.1" SVGA TFT Display
- 32MB 100MHz SDRAM
- 5GB[5] Ultra ATA Hard Drive
- Modular 24X Max CD-ROM
- 2X AGP 8MB ATI Rage Mobility™-M1 3D® Video
- Li-Ion Battery with ExpressCharge™ Technology
- Internal PCI V.90 56K Capable[6] FaxModem
- MS® Works Suite 2000 ■ MS® Windows® Me
- 1-Yr Limited Warranty[2]
- 1-Yr Next-Business-Day On-site Service[4]
- 1 Year of AOL Membership[40] Included

$1349 E•VALUE CODE 89250-801013

As low as $37/Mo., for 48 Mos.[17]

DELL™ INSPIRON™ 4000

NEW—Thin and Light

- Intel® Celeron™ Processor at 600MHz
- 14.1" XGA TFT Display
- 64MB 100MHz SDRAM
- 6GB[5] Ultra ATA Hard Drive
- Modular 24X CD-ROM Drive
- 2X AGP 8MB ATI Rage Mobility™-M1 3D® Video
- Li-Ion Battery with ExpressCharge™ Technology
- Internal PCI V.90 56K Capable[6] FaxModem
- MS® Works Suite 2000 ■ MS® Windows® Me
- 1-Yr Limited Warranty[2]
- 1-Yr Next-Business-Day On-site Service[4]
- 1 Year of AOL Membership[40] Included

$1699 E•VALUE CODE 89250-801016

As low as $46/Mo., for 48 Mos.[17]

DELL™ INSPIRON™ 5000e

Performance and Mobility

- Intel® Pentium® III Processor at 700MHz Featuring Intel® SpeedStep™ Technology
- NEW 15" Ultra XGA TFT Display
- 96MB 100MHz SDRAM
- 20GB[5] Ultra ATA Hard Drive
- Modular Removable 8X Max DVD-ROM Drive
- 2X AGP 16MB ATI RageMobility™ 128 3D® Video
- 59WHr Li-Ion Battery
- Internal PCI V.90 56K Capable[6] FaxModem
- MS® Works Suite 2000 ■ MS® Windows® Me
- 3-Yr Limited Warranty[2]
- 3-Yr Next-Business-Day On-site Service[4]
- 1 Year of AOL Membership[40] Included

$2999 E•VALUE CODE 89250-801029b

As low as $82/Mo., for 48 Mos.[17]

Copyrighted material

DELL™ DESKTOPS:

DELL™ DIMENSION™ L Series

Affordable Desktop Solution

- Intel® Pentium® III Processor at 733MHz
- 64MB SDRAM ■ 7.5GB[5] Ultra ATA Hard Drive
- 15" (13.8" vis) E551 Monitor
- Intel® 3D® AGP Graphics ■ 48X Max CD-ROM Drive
- SoundBlaster 64V PCI LC Sound Card
- PC Speakers
- V.90 56K Capable[6] PCI DataFax Modem for Windows®
- MS® Works Suite 2000 ■ MS® Windows® Me
- 3-Yr Limited Warranty[2] ■ 1-Yr At-Home Service[4]
- 1 Year of AOL Membership[40] Included

$899 E•VALUE CODE 89250-501008b

As low as $25/Mo., for 48 Mos.[17]

DELL™ DIMENSION™ 4100 Series

Advanced Performance, Smart Value

- Intel® Pentium® III at 800MHz
- 64MB SDRAM at 133MHz
- 10GB[5] Ultra ATA Hard Drive
- 17" (16.0" vis) E770 Monitor
- 32MB NVIDIA TNT2 M64 4X AGP Graphics
- 48X Max CD-ROM Drive
- SoundBlaster 64V PCI LC Sound Card
- harman/kardon Speakers
- V.90 56K Capable[6] PCI Telephony Modem for Windows®
- MS® Works Suite 2000 ■ MS® Windows® Me
- 3-Yr Limited Warranty[2] ■ 1-Yr At-Home Service[4]
- Pro8T2 SurgeArrest Surge Protector
- 1 Year of AOL Membership[40] Included

$1199 E•VALUE CODE 89250-501011

As low as $33/Mo., for 48 Mos.[17]

DELL™ DIMENSION™ 4100 Series

Advanced Performance, Smart Value

- Intel® Pentium® III Processor at 933MHz
- 128MB SDRAM
- 20GB[5] Ultra ATA-100 Hard Drive
- 17" (16.0" vis, .26dp) M781s Monitor
- 32MB NVIDIA TNT2 M64 4X AGP Graphics
- 12X Max DVD-ROM Drive
- SoundBlaster 64V PCI LC Sound Card
- harman/kardon Speakers
- V.90 56K Capable[6] PCI Telephony Modem for Windows®
- MS® Works Suite 2000 ■ MS® Windows® Me
- 3-Yr Limited Warranty[2] ■ 1-Yr At-Home Service[4]
- 1 Year of AOL Membership[40] Included

$1599 E•VALUE CODE 89250-501015y

As low as $44/Mo., for 48 Mos.[17]

DELL™ DIMENSION™ XPS B Series

Cutting-Edge Technology

- Intel® Pentium® III Processor at 1GHz
- 128MB RDRAM
- 40GB[5] Ultra ATA-100 Hard Drive
- 19" (18.0" vis, .26dp) M991 Monitor
- 32MB NVIDIA TNT2 M64 4X AGP Graphics
- 12X Max DVD-ROM Drive ■ 8x/4x/32x CD-RW Drive
- Turtle Beach® Santa Cruz DSP Sound Card
- Harman Kardon HK-595 Surround Sound Speakers with Subwoofer
- V.90 56K Capable[6] PCI Telephony Modem for Windows®
- MS® Works Suite 2000 ■ MS® Windows® Me
- 3-Yr Limited Warranty[2] ■ 1-Yr At-Home Service[4]
- 1 Year of AOL Membership[40] Included

$2499 E•VALUE CODE 89250-501024y

As low as $68/Mo., for 48 Mos.[17]

DELL™ SOLUTIONS:

SOFTWARE & ACCESSORIES

Printers:

- HP® DeskJet® 952C, add $199 after $50 HP® Mail-In Rebate (Reg. $249)[38]
- HP® DeskJet® 932C, add $149 after $50 HP® Mail-In Rebate (Reg. $199)[38]

Scanners:

- HP® ScanJet® 5300Cse, add $199 after $50 HP® Mail-In Rebate (Reg. $249)[38]
- HP® ScanJet® 4300Cse, add $99 after $50 HP® Mail-In Rebate (Reg. $149)[38]

Power Protection:

- Pro8T2 SurgeArrest, add $39

Software:

- Ultimate Sports Pack Plus (Dimension™ only)[16], add $99
- Home Reference 4-pack[16], add $79

FINANCING & SERVICES

Payment Solutions:

- Dell™ Purchase Plan – Enjoy easy-to-budget, low monthly payments. Systems as low as $25 a month[17] on the 48-Month Purchase Plan. Call now for fast, simple, and convenient processing.
- Dell™ E-Check – One convenient electronic payment from your checking account

Service Upgrades:

- Dell™ Dimension™ Premier 3-Yr At-Home Service[4], add $99
- Dell™ Inspiron™ 3800 and 4000 Notebook 3-Yr Next-Business-Day On-site Service[4], add $149

intel inside pentium® III

Includes Windows Millennium Edition — the home version of the world's favorite software.

[40]Must register for AOL within 30 days of receiving computer. To avoid paying monthly fees, cancel during 1st year promotional period. Even during promo period, telephone access charges on your phone bill (call your phone co. for details) and surcharges for premium services and 800# access may apply, including in AK. For new, 18+ U.S. members with major credit card or checking account only. Limited time offer. **[17]Monthly payment based on 13.99% APR. APR FOR QUALIFIED CUSTOMERS. OFFER VARIES BY CREDITWORTHINESS OF CUSTOMER AS DETERMINED BY LENDER. Taxes and shipping charges extra. From American Investment Bank, N.A. to U.S. state residents (including D.C.) with approved credit. Availability may be limited in some states.**

Prices, specifications, and availability may change without notice. Taxes and shipping charges extra, and vary. Cannot be combined with other offers or discounts. U.S. only. Offer valid for Dell Home Systems Co. only. [2]For a copy of our Guarantees or Limited Warranties, write Dell USA L.P., Attn: Warranties, One Dell Way, Round Rock, Texas 78682. [4]At-Home or on-site service provided via third-party contract with customer. Technician will be dispatched, if necessary, following phone-based trouble-shooting. To receive Next-Business-Day service, Dell must notify the service provider before 5pm (customer's time). Availability varies. Other conditions apply. [5]For hard drives, GB means 1 billion bytes; accessible capacity varies with operating environment. [6]Download speeds limited to 53Kbps. Upload speeds are less (about 30Kbps) and vary by modem manufacturer and online conditions. Analog phone line and compatible server required. [16]Software, packaging, or documentation may differ from retail versions. [38]For rebate details and coupons, call 800-728-9665. for HP, Intel, the Intel Inside logo, and Pentium are registered trademarks, and Intel SpeedStep and Celeron are trademarks of Intel Corporation. MS, Microsoft, and Windows are registered trademarks of Microsoft Corporation. America Online, AOL and the Triangle logo are registered service marks of America Online, Inc. 3Com is a registered trademark of 3Com Corporation. HP and DeskJet are registered trademarks of Hewlett Packard Corporation.

©2000 Dell Computer Corporation. All rights reserved.

DELL4me.com

contact us today | 800.757.1429 | www.dell4me.com | DELL.COM

Copyrighted

my notebook comes with next-day on-site service. and this afternoon I'll know where that is.

DELL™ INSPIRON™ 3800

Design and Affordability

- Intel® Celeron™ Processor at 600MHz
- 12.1" SVGA TFT Display ■ 32MB 100MHz SDRAM
- 5GB[5] Ultra ATA Hard Drive
- Modular 24X Max CD-ROM
- 2X AGP 8MB ATI Rage Mobility™-M1 3D® Video
- Li-Ion Battery with ExpressCharge™ Technology
- Internal PCI V.90 56K Capable[6] FaxModem
- MS® Works Suite 2000 ■ MS® Windows® Me
- 1-Yr Limited Warranty[2]
- 1-Yr Next-Business-Day On-site Service[4]
- 1 Year of AOL Membership[40] Included

$1349 E-VALUE CODE 89249-801013

Tell us where you are. Someone will come and fix your notebook. It's that simple.

Go ahead and ride like the wind. And don't forget to bring your notebook with you. Because wherever you end up in the 50 states, it's probably a place where a technician can arrive on-site to fix your notebook if something goes wrong. If you have a problem with your notebook, you can call us 24x7, for a tech to troubleshoot with you over the phone. Then, if hardware support is needed, a repair technician can be sent to wherever you are. It's called Next-Business-Day On-site Service[4] and it's available with every Inspiron™ notebook we sell. Of course, chances are you'll never need someone to drop by. But if you ever do, just find a phone. Dell4me™ is all about helping you get the most out of your PC. Our award-winning service and support is just one of the ways we're making it happen.

intel inside
celeron™ PROCESSOR

DELL4me.com

contact us today | 800.757.1429 | www.dell4me.com | DELL.COM

Includes Windows Millennium Edition — the home version of the world's favorite software.

[40]Must register for AOL within 30 days of receiving computer. To avoid paying monthly fees, cancel during 1st year promotional period. Even during promo period, telephone access charges on your phone bill (call your phone co. for details) and surcharges for premium services and 800# access may apply, including in AK. For new, 18+ U.S. members with major credit card or checking account only. Limited time offer.

Copyrighted material

my peanut butter and sardine sandwich?

personalized.

the pc dell built for me?

really personalized.

DELL™ DIMENSION™ L Series

Your Dream Machine

- Intel® Pentium® III Processor at 733MHz
- 64MB SDRAM ■ 7.5GB[5] Ultra ATA Hard Drive
- 15" (13.8" vis) E551 Monitor
- Intel® 3D® AGP Graphics
- 48X Max CD-ROM Drive
- SoundBlaster 64V PCI LC Sound Card
- PC Speakers
- V.90 56K Capable[6] PCI DataFax Modem for Windows®
- MS® Works Suite 2000 ■ MS® Windows® Me
- 3-Yr Limited Warranty[2] ■ 1-Yr At-Home Service[4]
- 1 Year of AOL Membership[40] Included

$899 E•VALUE CODE 89248-501008b

Inside your New Dell™ PC will be... whatever you want there to be.

At Dell™, we believe that personal computers should be, well, personal. Sure, all Dell PCs come with a powerful Intel® processor. But the rest is up to you. You don't have to be a computer expert. Just tell us what you want to do with your PC. Personal finances? Let Dell install the killer financial software you'll need. Music? We'll set you up, so you can download and play your favorite tunes. Games? Education? Internet? Just let us know and we'll make it happen. And with that Intel processor, it will happen fast. Keep in mind that your Dell PC will be backed by our award-winning service and support. Consider it just another way Dell4me™ can help you build your dream machine. Strange midnight snacks, on the other hand, are your department.

intel inside

pentium® III

DELL4me.com

contact us today | 800.757.1429 | www.dell4me.com | DELL.COM

Includes Windows Millennium Edition — the home version of the world's favorite software.

[40]Must register for AOL within 30 days of receiving computer. To avoid paying monthly fees, cancel during 1st year promotional period. Even during promo period, telephone access charges on your phone bill (call your phone co. for details) and surcharges for premium services and 800# access may apply, including in AK. For new, 18+ U.S. members with major credit card or checking account only. Limited time offer.

Copyrighted material